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The Animal Kingdom

CONSIDERED

ANATOMICALLY, PHYSICALLY AND
PHILOSOPHICALLY

BY

EMANUEL SWEDENBORG 1688-1772

PARTS 4 AND 5

THE ORGANS OF GENERATION, AND THE FORMATION
OF THE FOETUS IN THE WOMB

AFTER WHICH FOLLOW CHAPTERS ON

THE BREASTS AND THE PERIOSTEUM

TRANSLATED FROM THE LATIN AND EDITED BY

ALFRED ACTON

BOERICKE & TAFEL,
PHILADELPHIA,
1912

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PREFACE

The present translation was undertaken as a revision of the translation made by Dr. James J. Garth Wilkinson, and published in 1852; but while it is based on Dr. Wilkinson's translation, yet the changes made have been so numerous that it would be misleading to style the present work a revision. In saying this, however, justice and appreciation impel us to add an expression of our indebtedness to Dr. Wilkinson for many happy suggestions. Still our translation widely differs from the former one. In some cases the differences consist of a divergent, and even opposed interpretation of the text. In large part, however, they are due to our adherence to the principle that a translation should not only give the author's meaning, but, in addition, should give it, so far as possible, in the author's own style and sequence of ideas. In not a few cases the following of this principle has resulted in the development of meanings and distinctions not before observed.

Mention should be made of the skilful services of Mr. Alfred H. Stroh, of Stockholm, who has very kindly compared with the original MS. a number of what appeared to the writer as doubtful readings in the Latin text. For the benefit of the learned reader, such errors as have been detected are set forth at the end of the present volume.

In the quotations from the anatomists our author sometimes condenses the statements of his authorities; and in such cases we have preferred to retain the condensations whenever consistent with clarity of meaning, rather than quote direct from the anatomists. On the other hand, we have made a number of additions to the anatomical citations (all distinguished by brackets); but such additions have been confined to cases where they seemed necessary to a better understanding of some allusion in the text; see, for instance, n. 1 and 2, and confer n. 17 and 18. For the same reason new citations have been added in a few cases, namely, where a reference in the text involves the looking up of such citations; see n. 35a, 35b, and confer n. 42. With two exceptions (n. 35, 231), the author, in quoting from the anatomists, cites only the name of his authority, and the references to books, etc., were all supplied by Dr. Jo. Fr. Im. Tafel, who edited the Latin text in 1847. These references have been verified in the present translation, and we have also been fortunate enough to discover the sources of some citations which had escaped the painstaking search of Dr. Tafel.

In the original manuscript, the work on GENERATION is without a title; the title supplied in the present edition, and also in Dr. Tafel's Latin edition, is taken from a prospectus published by Swedenborg in Part I of the ANIMAL KINGDOM,—of which prospectus we shall speak presently.

The numbering of the chapters has been altered from the original, so as to commence with Chapter I, instead of XXVII, as explained below. Most of the paragraphs have been subdivided and paragraph numbers introduced. The paragraphs of the original, which are unnumbered, observe a certain definite order and plan, each paragraph dealing with one general phase of the subject in hand. But for the convenience of the student we have thought it advisable to divide these paragraphs, many of which are of considerable length. In making this division, we have adopted a different numbering from that of the former English edition, having in mind very largely the exigencies of indexing: that is to say, we have endeavored to divide the paragraphs so that each shall be confined to the treatment of some more particular phase of the subject in hand. In the Appendix, the reader will find a key to the paragraphs of the Latin edition and of the first English.

Our author follows the work on GENERATION by eleven pages of quotations from the writings of Schurig. With one exception, these quotations all concern the subject of generation, and we have thought it well to include in an Appendix such of them as have direct bearing on the points taken up by our author.

A word should be said as to the sequence of the three works, GENERATION, the BREASTS and the PERIOSTEUM, comprised in the present volume. In the original, these works occur in an exactly inverse order to that here adopted. We had at first contemplated retaining this order in the present translation, but reflection confirmed us in the wisdom of the arrangement adopted by Dr. Wilkinson. Indeed, this seems to be the natural sequence of the works, and, as we shall presently indicate, there are reasons to suppose that Swedenborg himself contemplated some such arrangement.

A number of foot-notes have been introduced, but the aim has been to confine these to an explanation of some reference in the text, and to the identification of anatomical terms. The latter end might have been served by a glossary, but inasmuch as the terms explained are usually confined to a single chapter, we have deemed it more useful to use foot-notes, thus enabling the reader to see the meanings at a glance.

A general index of the whole volume has been included, and also an index of authors and works. The plates have been selected by Dr. Felix A Boericke, to whose generous enterprise we owe the present edition of a work which has long been almost unavailable of purchase.

We wish now to address ourselves to a consideration of the place which this work occupies among the author's physiological writings.

* * * * * * *

The first physiological work published by Swedenborg is the ECONOMY OF THE ANIMAL KINGDOM, in two volumes or "Transactions" (1740–1741), the last chapter of which, entitled "The Human Soul," contains "the first-fruits" of the author's psychological labors (2 E. A. K., 218). According to some prospectuses found among Swedenborg's MSS., the ECONOMY was to have been completed by the addition of four more "Transactions," dealing with the Cerebrum, Cerebellum, Introduction to Rational Psychology, and Rational Psychology. But soon after the publication of Transaction II, the author contemplated a new series of psychological works, to be comprehended in four "Tomes," under the general title ANIMAL KINGDOM, in which the commencement should be made from the anatomy of the body. Some indication of this series is given in Transaction II of the ECONOMY, where we read:

> This (the discovery of the soul), and no other, is the reason why, with diligent study and intense application, I have investigated the anatomy of the body . . . and have followed the anatomy of all its parts, in the same manner as I have here investigated the cortical substance. In doing this I may perhaps have gone beyond the ordinary limits of enquiry, so that but few of my readers may be able to distinctly understand me. . . . . But thus far I have felt bound to venture, for I have resolved, cost what it will, to trace out the nature of the human soul. (2 E. A. K., 214.)

Now although Swedenborg had "followed the anatomy" of all the parts of the human body, the ECONOMY presents only the results of his investigations into the blood, heart and brain. In the new series, therefore, he designed to commence with the anatomy of the body, and from this to ascend in due order. The plan of the two series, as gathered from various sources,[1] is as follows:

Trans. I.	The Blood and Heart. Introduction to Rational Psychology.	Tome I.	1. The Viscera of the Abdomen. 2. The Viscera of the Thorax.
Trans. II.	The Motion of the Cerebrum. The Cortical Substance. The Soul.		3. The Heart and Blood. 4–5. Generation. 6. The Senses.
Trans. III.	The Cerebrum and Its Members.	Tome II.	7–8. The Brains and Medullas.
Trans. IV.	The Cerebellum and Medullas. Pathology.		9. The Fibre. 10. Motion. 11. Pathology.
Trans. V.	Introduction to Rational Psychology. The Fibre.	Tome III.	12. Introduction to Rational Psychology.
Trans. VI.	The Soul.	Tome IV.	13–17. The Soul.

In the meantime Swedenborg made first drafts of practically all the studies to be incorporated in one or the other of these series, and among such drafts are the three works included in the present volume. The general distinction between the "Transaction" series and the "Tome" series, is that in the former the anatomical citations are followed by an "Induction," whose several points are taken up in detail in separate paragraphs; whereas in the "Tome" series the citations are followed by an "Analysis," the propositions of which are confirmed in a series of foot-notes. A cursory examination would lead us to suppose that the works in the present volume belong to the "Transaction" series, since the expositions are headed "Induction," and are treated without foot-notes. But the internal evidence shows conclusively that they were written for the "Tome" series, that is as Parts, or drafts of Parts, of the ANIMAL KINGDOM.

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[1] A. K. Prospectus; 3, DOCUMENTS CONC. SWEDENBORG, 920, 925–6.

In the "Transaction" series, no mention is made of a work on Generation. It is true that this work contains "Inductions" and not "Analyses," but it would appear that when the "Tome" series was first drafted, the intention was to retain the style of the ECONOMY; and that the change to "Analyses" and foot-notes was made for the first time in the preparation for the printer of the finished copy of Parts 1 and 2 of the ANIMAL KINGDOM. Furthermore, it is plainly indicated in the Codex wherein the present works are found, that they were written after the first draft of Part 2 of the ANIMAL KINGDOM. This Codex (53) contains 269 pages, but more than half of the volume is missing. The Codex is paged by letters, the plan being to page from a–z, then from aa–zz, etc., each letter representing usually a whole sheet of four pages, marked a, a1, a2, a3, etc. As now preserved, the Codex commences with page llll, indicating that there were about 308 preceding pages. These pages, which were perhaps contained in a separate volume, are now missing, but the strongest indication of their contents is furnished by the opening words on p. llll, which are written in continuation of the last words of the missing pages. Translated, these words read:

> or rest, hence to this central spot. This also is the reason why it is discriminated into lobes. It comes to exactly the same thing if it be extended beyond the thorax through the trachea; this (or, it) contributes solely to the abundance of the fluid, and not to its determination elsewhere; for it flows and creeps within its tunic, and indeed is determined to the same centre; and if it should flow out, it could relapse only along the trachea, and finally into the mediastinum, which stands somewhat open at a station midway between the sternum and the vertebræ, and whence there is a continuation into the whole cellular tract of the mediastinum.

Then follows the work on the PERIOSTEUM, headed with the chapter number "23", and that on the BREASTS, marked "24."

The above fragment evidently constitutes the closing words of a chapter 22 on the subject of the thymus gland; see A. K., 435–6, 441. In view of this, and remembering that the missing pages, of which this fragment is the conclusion, number over three hundred, the conclusion is inevitable that these pages contain Parts 1 and 2 of the ANIMAL KINGDOM, or a draft thereof.

This conclusion is convincingly confirmed by a MS. left by Swedenborg, in which he has written out the proposed contents of the several chapters which are to make up the four Tomes of the ANIMAL KINGDOM (VI Photo. MSS., 349). According to this sketch, Tome I was to contain 23 chapters, which are enumerated, on the Abdomen and Thorax (Parts 1–2); 18 chapters on Generation[1] (Parts 4–5,—no mention is made of chapters on the Blood, Part 3), and 5 chapters on the Senses (Part 6). And comparing these chapter-headings with Parts 1 and 2 of the ANIMAL KINGDOM, as published, and with the work on GENERATION, we find that, with an almost insignificant rearrangement, the outline agrees with the works as written. But the special point to which we would call attention is that in the outlined contents of Parts 1–2, on the Viscera, the last chapter is that of the Thymus Gland. This chapter is numbered "23", but by not counting Chapter I, containing "The Plan of the Whole Work and Its Divisions," it would constitute chapter 22. In any case it is the last chapter of the Parts 1 and 2, on the Viscera, whereas in the published work it is followed by another chapter on the Diaphragm.

Following this outline, Swedenborg proceeded to write a first draft of Parts 1–2, the last chapter being "22 On the Thymus Gland." He then enlarged his plan by including two additional chapters, namely, "23 THE PERIOSTEUM," and "24 THE BREASTS." These two works would, therefore, seem to have belonged to Part 2 of the ANIMAL KINGDOM, as first drafted.

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[1] These chapters are as follows: "In the Male: 1. The Spermatic Vessels. 2. The Testicles. 3. The Epididymides. 4. The Vasa Deferentia. 5. The Prostate. 6. The Urethra. 7. The Penis. 8. The Seed. In the Female: 9. The Vulva and Pudenda. 10. The Vagina. 12 (*sic*). The Ovaries. 13. The Fallopian Tubes. 14. The Uterus. 15. The Chorion and Amnion. 16. The Placenta. 17. The Umbilical Cord. 18. The Infant. 19. Birth."

After chapter 24, on the Breasts, the MS. continues with "25, The Ear;" "26, The Eye;" "27, The Spermatic Arteries," and so on, from Chapters XXVII–XLIV of the work on GENERATION. This is followed by eleven pages of excerpts from Schurig, and 88 pages from other authors.

From the evidence thus far adduced, we reach the conclusion that Codex 53, including the missing 300 pages, contained the first draft of Parts 1, 2, 6, 4, 5 of the intended series on the ANIMAL KINGDOM, namely, the Viscera (pts. 1–2), Senses (pt. 6), and Generation (pts. 4–5). This makes clear the many references in the PERIOSTEUM and GENERATION, to "Above" (see Index of Authors, s. v. *Swedenborg*),—which references are plainly to the Parts 1 and 2 of the ANIMAL KINGDOM, which were actually "above" in the manuscript.

These first two Parts were afterwards rewritten for publication, and in the rewriting the order of the work was slightly altered. Two chapters were added, including the last, on the Diaphragm, but chapter 23, the Periosteum, and 24, the Breasts, were omitted,—perhaps because the author had decided to add them to Part 5 "On the Female Organs and on the Fetus in the Womb," to which the nature of their contents would seem naturally to assign them. In the recast and enlargement of this draft, Swedenborg seems to have adopted for the first time the "Analysis" and foot-notes that distinguish the ANIMAL KINGDOM and the subsequent drafts of Parts thereof. It is very probable also that, had he rewritten the work on GENERATION, the portions now printed in italics would have formed the text of the work, and the remaining matter have been in foot-notes; indeed, the abrupt style of this latter, even as it now stands, frequently suggests a series of foot-notes rather than a running comment.

The date of the work here presented to the reader is put by Dr. R. L. Tafel as 1742–3. Swedenborg commenced Parts 1 and 2 of the ANIMAL KINGDOM immediately after his return to Sweden, in November, 1740 (2 Doc. 130). In a petition to the king, after referring to a leave of absence granted some time before, "to bring to completion a work which I had written" (the ECONOMY), he prays for a two years' leave, because "this same work must needs be continued, as I also have promised to the public." He adds that he has completed the greater part of this continuation," *i. e.*, the ANIMAL KINGDOM. (New Church Life, 1896, p. 167.) In a similar petition to the College of Mines he adds, that he has been laboring at this work ever since his return to Sweden (November, 1740), and that the part he wished to publish, "after collecting some necessary information from the libraries abroad, will amount to about 500 sheets" (1 Doc. 458–9).[1]

Between November, 1740, and June, 1743, he had, therefore, written the first draft of Parts I and II of the ANIMAL KINGDOM, *i. e.*, chapters 1–22 of Codex 53; and had also almost completed the rewriting for publication in about 500 sheets. Making due allowance for the time necessary for the clean copy, we conclude that Codex 53 was written between November, 1740, and the autumn of 1742; and making due allowance for the 300 pages of the first draft, and the 85 pages on the Periosteum, Breast, Eye and Ear, we conclude that the work on GENERATION was written during the beginning of 1742. Of course, the work might have been written after the publication of the ANIMAL KINGDOM, especially in view of the fact that in Part I of that work the author announces that the Part on Generation will precede that on the Senses, whereas, in Codex 53, he has already changed the order of the works, a fact which he does not announce till 1744. Yet the whole style of the work on GENERATION, especially the absence of any reference to extraordinary spiritual guidance, such as distinguishes his later physiological writings, would seem to indicate the earlier date; and it may be that thus early,—that is, before the publication of the ANIMAL KINGDOM,—Swedenborg had an inkling that the order there announced would probably have to be changed.

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[1] These petitions plainly show that Swedenborg regarded the ANIMAL KINGDOM as a true continuation of the ECONOMY, and not as a substitution, as is often supposed.

In the first of the two Parts of the ANIMAL KINGDOM, published in 1744, the author announces that the whole work will be comprised in seventeen Parts, Part 3 to treat "of the Blood," etc., 4–5, "of the Organs of Generation of both Sexes, and of the Fetus in the Womb," and 6, "of the Senses." But in the following year, 1745, he published in London, Part 3, on the senses of Touch and Taste. In the Prologue to this work he explains this departure from the original plan by stating that the blood, etc., had already been dealt with in the ECONOMY, and that the subject of Generation could not be taken up before the Soul had been treated of (2 A. K., 469).

A similar but longer explanation is given in the second draft of the work on the SENSES,—the first draft being the chapters preceding the work on GENERATION,—and we may be pardoned if we quote this explanation at length. Before doing so, however, we would again call attention to the fact, emphasized by the quotation itself, that the present work on Generation must be considered as a first outline or sketch, and that had the author re-written it for publication to follow his teachings concerning the soul, it would have been much amplified. Yet, even as it is, it evidences throughout, the presence and all-ruling influence of those doctrines, both published and unpublished, concerning the human soul, which had been formulated by the commanding genius and the penetrating perception of its author.

And now for the quotation. After alluding to the ECONOMY, our author continues:

> The generative organs, especially in males, are dedicated not to the blood, but to the spirits which run through the fibres and adapt themselves to the most perfect forms of nature, in which forms they so receive the very life or soul of the parent, that the genitura or seed prepared therefrom is suitable for producing what is similar. And, therefore, since it is thus far still unknown what the animal spirit is and what the soul, wherein that life lies, to examine the organism would surely be like unraveling the instrumental cause without any knowledge of the principal cause, when yet the organic or instrumental cause together with its principal makes one cause. Wherefore, I do not see that I can proceed thither, that is, can disentangle the subject of the generative members, until I have first laid down what the brain is, what the fibre, and what the animal spirit and the soul. This is the reason why it behooves me at present to pass by the exposition of the generative members. For, as was said, it

would be merely putting forth words not understood, and involving science in shade rather than evolving it from shade. . . . I wish first by our analytical way, by means of anatomical experience and with doctrines to lead us by the hand, to reach to a knowledge of the soul, and thus to make smooth the steps, that we may afterwards return, and as it were descend to those organs. For the analytical is to ascend and afterwards thence to descend, resting on those ladders whereby we ascend, for there do we borrow wings. Furthermore, these generative organs are organs of more perfect nature, as it were: for they are the campus for the exercises of Loves, and are the native land, or Cyprus of Venus, and thus the Olympus of all delights; and we cannot reach these organs except from what is prior and superior. For they are the center of all pleasures, and the dwelling places, as it were, of the superior life, since they have for their end superior loves which descend from the very soul, and regard the procreation of human society and the propagation of heavenly society. And, therefore, they are entirely above the sphere of those organs which constitute the inferior parts of the body. Thus it behooves us to descend to them, but not by their means to ascend to superiors. Moreover, they are separate from the other viscera, and constitute a separate or central region of the body, as, for instance, the testes and so forth. Nay, we do not come into the use of these members until about the time of youth, or rather, of adult years. Moreover, they constitute a new and, as it were, more pleasant, happy and heavenly life; as is apparent in the case of insects, which, as worms, live long for their appetite and stomach, but finally put off their first life, and put on the life of Venus, when, under another form, they are furnished with wings, like butterflies, sport over the earth in the air as in their heavens, and give their labor to procreation. Therefore, we leave this part as yet, until we shall come to a knowledge of superior things, and shall have grown a little older in the knowledge of things; herein imitating Nature herself, who teaches us the way. (*Senses*, 6–10.)

Much might be said as to the unique importance of the work now presented for the second time in English dress; and we might expatiate on the intuition of the author who, in the multitude of detail, has steadily followed the golden thread of reason. But we prefer to leave such matters to the judgment of the reader, and will content ourselves with pointing out how that Swedenborg, in his examination of this "Fourth Kingdom" in the human body, has kept in view that the use of the kingdom is the propagation of earthly and also of heavenly society. To him this kingdom is the kingdom of Conjugial Love, and it is from this standpoint that he searches into its uses and gives the truth concerning its abuses. This is the spirit that characterizes his work, and distinguishes it from all other works on the subject, even those whose conclusions may seem more or less similar.

In our author's exposition of the laws of this fourth kingdom and of the operation of those laws, the reader will find the fitting, and even the essential ultimates for a fuller and deeper entrance into the arcana revealed by the Lord through Swedenborg in the inspired work entitled CONJUGIAL LOVE. In all human life, no love is so universal, none so delightful, none whose abuse is so fraught with human misery and the wreckage of human life, and none so important to be known,—and known from the standpoint of heaven and of enlightened reason.

Bryn Athyn, Pa., October, 1911. ALFRED ACTON.

THE
ORGANS OF GENERATION
THE MALE ORGANS

CHAPTER I.

THE SPERMATIC ARTERIES.

1. **WINSLOW.** (*Exposition Anatomique.*) The spermatic arteries arise most commonly from the aorta, about an inch or more below the renal or emulgent arteries.[1] Their origin, however, varies. Winslow has observed them to arise from the renal artery, sometimes higher up or lower down, and sometimes from several origins. They descend obliquely in the posterior part of the abdomen within the cellular tissue of the peritoneum, passing gradually from behind forward. Parting from the aorta, they cross the ureters in front, and run through the openings or rings of the abdominal muscles to gain the elongations or productions of the cellular portion of the peritoneum. They are very small at their origin, and in their course downward they give off very considerable lateral ramifications to the adipose tissue and the peritoneum, and also to the mesentery, where they seem to communicate with the mesenteric arteries. They sometimes pass through the areolæ or meshes of the spermatic veins; and before leaving the abdomen they divide into fine twigs, almost parallel to each other and more or less serpentine, which proceed in the same direction. Afterwards they insinuate themselves into the cellular productions of the peritoneum, which serve them for sheaths. They do not fluctuate indifferently from one side of these sheaths to the other, but are attached along the whole length of the inner surface of the sheaths by thin membranous laminæ, which are likewise continuations of the cellular tissue of the peritoneum. They continue the same winding course within these sheaths [passing before the vasa deferentia, which are likewise contained in the sheaths], and at length they terminate by ramifications on the testes and epididymides. (*Tr. du Bas Ventre,* n. 469–474.) The spermatic

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[1] See Plates I and VIII.

arteries are commonly two in number, sometimes more. They go off from the aorta near each other and between the two mesenteric arteries. They send small branches, called arteriæ adiposæ, to the common membrane of the kidneys. They give several considerable branches to the peritoneum. They likewise send branches to the ureters. Afterwards [where they are distributed to the testicles and epididymides], they communicate with a branch of the external iliac. [The epigastric artery[1] sometimes gives off two particular branches, one of which goes to the triceps muscle, etc., and the other runs down as far as the testicles along with the spermatic artery, with which it there anastomoses.] (*Tr. des Artères*, n. 219–222, 235.)

2. The spermatic veins accompany the arteries ana have nearly the same course. The right vein arises commonly from the trunk of the vena cava, though I have also observed it to spring from the union of the right renal vein with the vena cava, and sometines I have seen three spermatic veins on the right side coming separately from the trunk of the vena cava. [The left spermatic vein arises usually from the left renal vein.] In their course downward, they join the arteries, and together with them enter the cellular productions of the peritoneum, to which they are attached in the same manner as the arteries. From their origin to their passage through the abdominal rings they give off several branches in the same way as the arteries. A little below the place where they cross the ureters, they send out a considerable branch, which afterwards divides into two, one of which communicates with the capsular or suprarenal vein, and the other frequently with the renal. They differ from the spermatic arteries not only in being larger and their coats thinner, but also in being more divided and multiple as they descend to the rings of the abdominal muscles; and because they thereby produce a bundle of ramifications which becomes larger and larger as it proceeds, the ancients gave to them and to the arteries the name *pyramidal vessels*. These ramifications frequently communicate with each other during this course and form a great

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[1] The internal branch of the external iliac; called also the deep epigastric.

number of areolæ, contortions and convolutions, so as to represent a kind of network, which is attached to the cellular sheath of each side, by fine leaf-like membranes. These frequent convolutions gave rise to the name *pampiniform vessels,* formerly given to the spermatic vessels in general; and the adhesions of these vessels to each other in certain places has led to the belief that there were real anastomoses between the artery and the vein. [An Italian anatomist, Leal Lealis, believed himself able to establish the existence of these pretended anastomoses by demonstration; but the experiments which he made on living animals proved nothing. In these experiments he made a common ligature on both vessels a little above the testicle, and a special ligature on the trunk of the vein, which he had previously emptied. He then pressed the aorta so as to force the blood into the spermatic artery, and he then found the vein which he had previously emptied to be entirely filled. From this he concluded that, in the space between the two ligatures, there must be some anastomosis whereby the vein was supplied with blood. But it is quite clear that this effect was owing to the lateral ramifications of one or other of the spermatic vessels, and not to his pretended anastomosis of artery and vein; and that the fineness of these ramifications, which were well known to Eustachius, resulted in their escaping the attention of Lealis.] (*Tr. du Bas Ventre,* n. 475–482.)

3. **Heister.** (*Compendium Anatomicum.*) The bloodvessels of the uterus,—tortuous, forming innumerable anastomoses with each other, and, in women with child, dilated into as it were sinuses,—open by little mouths into the uterus and vagina, and are the sources of the menstrual discharge. The arteries of the uterus are: 1. The spermatics from the aorta. 2. Very large vessels from the hypogastrics. 3. Vessels from the external hemorrhoidals. All these vessels are in such wonderful communication with each other that if any one of them be inflated or be injected with wax or mercury, all the others, even those of the opposite side, are quickly filled. The veins also are threefold, and have the same names as the arteries. They have no valves, and are much larger than the arteries, especially in women with child. By inflating them, air may be thrown into the cavity of the uterus and vagina;

and, on the contrary, through the latter it may often be thrown into the veins.[1] (n. 236.)

4. The spermatic arteries do not always arise from the aorta, but the left spermatic occasionally comes off from the emulgent, and both the right and left sometimes proceed from the hypogastrics. This can scarcely have been noticed by those who say that the spermatic arteries are sometimes altogether wanting. Lealis and Schrader maintain that the spermatic arteries before reaching the testes anastomose with the veins; but this is not borne out by the testimony of others. (*Nota*, 25.)

5. Boerhaave. (*Institutiones Medicæ.*) The seminal or spermatic arteries, arising with the greatest constancy from the front of the aorta below the renal arteries (though sometimes, perhaps improperly, the left seminal or spermatic is said to come from the left renal), not being vessels of large size, and also because of their oblique descent from the aorta, can hold but little blood. They run obliquely downward and join at an acute angle with the spermatic veins of the same side, of which the right comes from the vena cava under the renal vein, and the left from the renal vein. Thereafter both arteries and veins are enclosed and as it were blended together in one common membranous sheath. Thus protected, they run under the inner layer of the peritoneum over the psoas muscles and the ureters, until they reach their place of exit in the groin. Here the fleshy fibres of the transverse muscle lie over them, and those of the inferior oblique, slightly separating so as to leave a little interspace, transmit the vessels with their enclosing sheaths; thus the transverse muscle, where they pass under it, is the highest, the oblique ascending muscle, which transmits them, being lower down. Then about three lines lower still, they again pass through an oval aperture in the tendinous part of the oblique descending muscle; and lastly the sheath with its vascular contents is carried over the pubic bone and into the scrotum; where, out of its vessels and membranes, it constructs the testis. Throughout this course the spermatic artery gives off small lateral twigs here and there.

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[1] See n. 217 below, where this passage from Heister is again quoted, and consult the notes there.

Add to this that each of the three openings of the muscles through which the sheath passes, bestows upon it a fine and delicate little membrane; but where the group of vessels approaches the testicles, the former constitute the corpus pyramidale. In its passage the spermatic artery, slightly winding in a spiral manner, gives off little branches which, running in a straight, open and somewhat ample course, derive the arterial blood laterally by true anastomoses into the accompanying vein. This is especially the case in the corpus pyramidale, where the artery near the testicle gives a branch to the lower and inner part of the epididymis. Sometimes also the artery sends another branch to the upper part of the testicle, and constantly a large branch to the upper and larger part of the epididymis, where it ramifies and is distributed in all directions. Not to mention numerous little branches from the larger trunk, closely interwoven and communicating with the little veins in the corpus pyramidale, and afterwards spread over the compass of the testis. The corpus pyramidale, called also the varicose or pampiniform body, arising from the back of the testis, consists of innumerable veins communicating with each other, and which form a kind of net and at last unite and terminate in a single seminal vein. (n. 641–643.)

6. SCHURIG. (*Spermatalogia.*) [Cases where no spermatic arteries could be found although the spermatic veins were plainly visible.] The same has been noticed in the dog, hare and wolf. [A case where both spermatic arteries were lacking, but a small branch of the hypogastric was found running to the testicles. In an old man who had complete potency only one spermatic artery could be found.] Poupart tells of a girl of seven years in whose left side he could find no sign of either spermatic artery or spermatic vein. Some authors tell of three spermatic arteries, others of four, and some enumerate six and even seven. (II, § 2, 3, 6–7.[1])

7. WINSLOW. (*Expos. Anatomique.*) The psoas is a long thick muscle occupying the lumbar vertebræ at the posterior part of the ileum all the way to the anterior part in the direction of the femur. It is attached above to the last dorsal and to all the lumbar vertebræ, whence it descends obliquely over the ileum. Before leaving the abdomen it unites with the iliac muscle. [It passes in front of the head of the femur, which it covers, and is finally attached to the anterior part of the little trochanter.] It serves to flex the femur upon the pelvis, by drawing the latter forwards. It can also move the pelvis upon the femur. (*Tr. des Muscles*, n. 364–367, 977.)

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[1] For further citations from Schurig, see Appendix, n. 13.

INDUCTION.

8. *The wonderful manner in which all things in the animal body are disposed and ordered, is evident, on the slightest reflection, from the situation of the parts according to their use. In the highest place resides the brain, which is meant to be sentient of all things and to govern all, and which, therefore, proximately surrounds itself with sensory organs and distributes motory organs round the whole corporeal machine. Next underneath it the lungs and heart have their place in the body above the diaphragm. These organs put motion into all the parts, in particular and in general, enabling the animal frame to live in motion. Next under these and separated from them by the diaphragm, are planted in the cavity of the abdomen and within the peritoneum, the viscera, which nourish, sustain and provide for all things in the body, especially for the blood, so that, like as it came into existence, so it shall perpetually subsist. Below this region again, and outside the peritoneum, the members devoted to generation and the propagation of the species have their allotted places. Thus as all are allotted their offices, so are they allotted their provinces. The whole machine,—the universal little world or microcosm,—is provided moreover with extended arms, loins, legs, feet and soles to capacitate it for application and motion according to all the circumstances that the use and necessity of the above mentioned parts can possibly require. That is to say, to enable it to obey the brain in all respects; to live in society as a member or part of the state; and finally to adapt and rouse itself for the several movements of the heart and lungs; for the several movements of the viscera of the abdomen, or of the functions of nutrition; and for the several movements of the organs of procreation, both towards the act and in it. All those actions which regard the above-named uses are the primary actions of the appendages of the body, that is, of the arms, loins, legs and feet; all the rest are secondary, and they exist inasmuch as they regard the*

primary, and not because they regard the secondary acts. Thus the primary actions of the loins and feet are meant to enable the body to take the steps and to make the due approaches for the act of coition, with a view to the propagation of the species; to enable it to seek, apply, and take in food and aliment for the sustenance of life; likewise to minister to the divers workings of the lungs; and finally, in all particulars to second the commanding brain which regards the general society. Other offices which do not regard these directly, and also those which are contrary to this use, we term secondary. These may indeed be performed, not however for the end that they may be performed, but because, for the sake of the uses mentioned above, we are gifted with the faculty of performing them.

9. *The propagation of the human race is the one and principal of all primary uses and ends; for thereby is raised up not only an earthly society but also the heavenly society of souls. For the sake of this use we are gifted not only with organs of wonderful structure, but also with the affection called venery, which surpasses all other affections; namely, to excite us to follow this end by a certain most pleasant and delicious violence and necessity. From this same necessity it follows, that the several means which regard and promote this end are abundantly and wisely provided according to the full measure required.*

10. *Among these means the blood undoubtedly takes the lead, being itself the very storehouse from which the genitura*[1] *or seed is prepared. The blood is the parent of all the humors of its body, containing as it does the simplest elements of every degree, by the subordination and due co-ordination whereof, whatever of humor or essence is possible in this sublunary sphere may come into existence.* See Transactions I and II.[2] For besides the elements and principles of all parts of the mineral and vegetable kingdoms, it contains also the principles of the animal kingdom, that is to say, the animal spirit in which is the life and soul. See Transaction I, also our psychological observations respecting the animal spirit and the soul in the sixth or last Transaction.[1]

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[1] By *genitura* seems to be meant the mass of the seed. See Appendix n. 11, where genitura and seed are distinguished; confer also Index, s. v. *Sperm*.

[2] The reference is to the ECONOMY OF THE ANIMAL KINGDOM, which was to consist of six "Transactions." See Preface.

11. *In order, therefore, that the blood, which is the parent both of the seed* (genitura) *itself and of the several principles that must lie in the seed in its process of formation, may be rightly conveyed to the preparing organs, as the testicles, epididymides, uterus and Fallopian tubes, necessity requires:* FIRST. *That only the purest blood, cleansed from every excrementitious quality, have admission thither, and moreover, blood that is resolvable in the most perfect manner into its elements.* SECOND. *That the quantity of such blood be no greater than the particular state and natural necessity require.* THIRD. *And that there be an ever new supply and a fresh and greater abundance during the act, that is, during coition.* FOURTH. *That this blood be not hindered in its afflux, but be supplied with certainty.* FIFTH. *And thus be conveyed to its destination by the safest way.* These are the points to be aimed at and kept ever in view during our examination of the spermatic vessels, if we would rightly explore the use of those vessels, and not fix our ideas upon foreign objects that do not properly regard the end.

12. *With regard to the* FIRST: *That none but the purest blood runs to the generative organs, and this to the end that the spirituous essence of the blood may be extracted and be spent upon the seed* (genitura); *and hence that this blood be of the softest kind and readily resolvable into all its elements and principles,—this is clear from many considerations.* [i] *For the spermatic vessels, few or many, come off from the aorta immediately under the emulgents; and the emulgent or renal vessels are those which draw off all the unclean and obsolete portion of the blood and throw it in the form of urine into the kidneys and bladder and finally out of the*

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[1] The sixth Transaction was planned for fourteen chapters, as follows: 1. The Body. 2. The Soul in General. 3. The Animal Spirit. 4. The Blood. 5. Sensation. 6. Imagination. 7. The Mind. 8–14. The Soul. The published work RATIONAL PSYCHOLOGY covers only the subjects indicated for Chapters 5 to 14. The subjects of Chapters 2 and 3 are dealt with in two small works (The Animal Spirit and the Soul), published in POSTHUMOUS TRACTS, and which were probably intended as parts of Transaction VI. To these, therefore, the reader is referred.

body. Thus the blood is cleansed in the upper part of the aorta, before it is delivered to the spermatic vessels. According to the description prefixed to the chapter, the spermatic vessels are given off from the aorta about a finger's breadth, more or less, below the renal arteries, which are the emunctory vessels that cleanse the blood of its dross. In some subjects, however, they arise from the emulgent or renal vessels themselves, as observed by Heister [n. 4], and also by the older authorities; in others again they come from the hypogastric and hemorrhoidal vessels. From the latter cases it may indeed be thought that the blood is not purified by the emulgent arteries for the purpose of being supplied in a cleaner state to the spermatic vessels. On the other hand, however, we must give equal attention to the fact that if the latter do arise from the emulgent or any other artery, still, in their course and during their long passage, means of expurgating the blood are abundantly provided, and these means are the more considerable and numerous in proportion as the vessels under discussion spring from places in which the blood is rendered impure. This is the reason for the ramifications of the spermatic artery, and for the derivation of its blood into these or other arteries to be mentioned presently; and from this undoubtedly must be deduced the cause of the variation.

13. [ii] *Still the general rule holds good that the beginnings and middles have to convey and supply such blood as the extremes expend and demand; and not only the quality of blood they consume, but also the quantity. Thus the emulgents take none but the more impure blood, which has a urinous quality; the testes and epididymides, the fixed, pure and readily soluble blood; so likewise the brain and the rest of the viscera.* Thus it amounts to the same thing whether the spermatic artery comes off from the emulgent, the aorta, or the hypogastric, for it is the testicles that command the quality and the proper quantity. Suppose that a large quantity of purer blood is attracted in the extremes; in this case, if this purer blood is taken in, a corresponding quantity must be restored by the antecedent arteries; so also in the case of the grosser blood. This disposition depends on the organ itself which consumes and expends the blood. If we carry out a number of tubes from a common channel, and draw off by one of them a certain quantity of water, but a smaller quantity by the others, still, according to the attractive powers exerted upon the water at the extremities, is the quantity that runs from the common channel or fount. The like is also the case if a certain quality of blood be drawn off. In this case, nature, which ever strives after equation, could not be rightly equated if such blood be taken in in undue quantity; and, therefore, she furnishes a supply equal to the necessity. From this requirement and dispensation it follows that the intermediate vessels are necessarily so disposed that they give passage to a certain kind of blood and to no other; and if they give passage to other blood also, they send it off in another direction. This is what we term the equation of the blood, and this it is from which all the above effects result. See Transaction I.[1]

14. [iii] *In order that the purer and more soluble blood may be derived into the testes and epididymides, it is necessary that the spermatic artery come off from the aorta by a fine opening or narrow orifice; and also that the blood be purified on the way, that is to say, that, as it runs onward, the more worthless, watery and urinous part, or the excrementitious portion, be completely detached, and none but the purer part remain, which shall serve the use of preparing the seed* (genitura). That the spermatic vessels arise from the aorta by a fine and narrow opening is established by observation; likewise that the artery descends towards its proper organs by a long course so that on the way it is able to duly purge itself of heterogeneous matters; for the longer the course, the greater the opportunity of expurgation. First it throws off the grosser, then the purer heterogeneous elements; thus first the urinous, then the aqueous, and then again the oily matters that are not suitable for the seed (*genitura*). This is the reason why the spermatic vessels transmit branches towards the kidneys and also towards the superior or suprarenal capsules; and moreover to the adipose membrane of both the skin and the kidneys; and finally a number of twigs to the peritoneum, whose cellular tissue receives the aqueous portion of their blood. By this means the urinous matter is without doubt evaporated through the skin (see above[1]), or sweated off. And finally those crudities that from other places are sent away to the liver, are committed to the mesenteric arteries. Besides this, the spermatic artery, throughout its whole course, communicates with the iliacs and is connected with the veins thereof. Thus, whatever is bound in with the blood is rejected; that is to say, everything in the blood which is not soft and soluble, but is hard, and unfit for this use. Hence all the channels for discharge and purging are sufficiently provided. Add to this that a certain kind of blood is necessarily sent away through these channels according to the rule just explained, namely, that the extremes demand the precise [quality and] quantity of their blood. So it is with the emulgent arteries, the peritoneum and the adipose membrane; so also with the mesentery and the liver,—all of which command their own supply. For wherever blood of a similar sort is flowing, by whatever windings it passes, it is still conveyed to its destination; for by reason of the above-mentioned equation, the whole system concurs to these effects or ends.

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[1] See 1 E. A. K., particularly n. 227, 343 v, 349.

15. [iv] *The viler part of the blood being thus cast away, the purer remains. But in order that none but the purest may enter, the spermatic vessels are finally divided into capillaries and threads, and after in this wise splitting up, they pass to the corpus pyramidale or the tubular offset of the peritoneum. For the finer the branches into which an artery divides, or the purer the threads through which the blood runs, so much the more purified must the blood itself be, and so much the more cleansed of its heterogeneities.* This is an evident truth resting on ocular experience. None but the pure, true and genuine blood can run through the finest vessels; for if anything angular, gross or hard were to get in with it the hair-tube would be inevitably obstructed and the current stopped. This was excellently seen by Leeuwenhoek, who observed in the finest capillaries only pure blood, without that volume which results from multiplicity,—sometimes seeing the solitary globule, and sometimes the same divided into its principles, that is, into six globules; see Transactions I and II.[1] The case would be otherwise if the artery had a thick coat. Hence the splitting up of the spermatic artery into such vast numbers of ramifications is a clear proof that the little branches receive and transmit the purer blood only. And since this division takes place at the extremity of the vessel, it follows that here, that is to say, in the neighborhood of the testes and epididymides into which it enters, the blood is sufficiently purified.

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[1] The words "see above" in the present work, where they do not refer to the work itself, have reference to preceding parts of the ANIMAL KINGDOM; see Preface. The present reference would seem to be to 2 A. K., n. 470 *seq.*, particularly n. 510–511. This would indicate that a draft of the chapter on the Skin had been written previous to the work on Generation. Two such drafts are found among Swedenborg's manuscripts; see 6 *Photolithograph MSS.*, p. 1–11, 42 *seq.*

16. [v] *The necessary conditions of the greater purity of the blood are, that it be quite soft, thin, and resolvable into all its elements, hence that it be rich with abundant spirit, and thus be able to bring out this spirit from its bosom with the utmost readiness.* Such is the blood required by the seed (*genitura*), which is pregnant with much spirit and abounds moreover with the purest elements which lend that spirit every assistance enabling whatever is in it from first principles, to begin to arise anew.

17. [Second.] *That a sufficient quantity of blood may be carried to the organs, and this in no greater abundance than reason and necessity would have; that is to say, that the blood be neither over abundant nor too sparse; and just as though all the blood that flows in were to be turned to seed* (genitura),—*this also is most prudently provided for in the spermatic vessels. For these vessels rise not merely from one but sometimes from several origins; arising by one, two or more origins from the aorta, and also from the hypogastric and hemorrhoidal vessels.* Anatomy shows that the spermatic vessels are produced not only from the aorta, or from the emulgent artery, but also from the hypogastrics and hemorrhoidals. Mention is also made of a branch from the epigastric vessels accompanying them, and at length at the end of their course twining in with them; see Winslow [n. 1 *fin.*]; and of an abundant supply being received from the hypogastric. Some anatomists have discovered two, three, and as many as five branches from the aorta coalescing into a single spermatic trunk. Others again have reported finding no spermatic trunk, even in persons who had conceived offspring; in which cases the spermatic vessels doubtless came, not from the aorta but from the hypogastrics. Thus the due quantity of blood can never fail, nor the generative faculty be endangered, for when one source is blocked, a supply is opened up from another.

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[1] See particularly 1 E. A. K., n. 29, 96; 2, n. 122.

18. *In order that a quantity of blood that has once been purified may always be on hand, and not slip away before it has done its use, provision is made that the pampiniform vessels, or the arteries, shall not communicate with the veins within the sheath or production of the peritoneum, that is, in the corpus pyramidale, lest the purest arterial blood thus slip away by the channel of the veins.* The blood which runs here is purified and apt for generating seed; that is to say, it is soft and relatively pure and soluble. But if in this place it were allowed communication with the venous blood, the intention of nature might be frustrated. Leal Lealis, by his experiments, seems to have wished to establish a communication opposed to this intention; but he is contradicted by Winslow, Heister and other illustrious anatomists. *For the communication of the arteries with the veins takes place above these ramifications but not within them. Below, however, upon the testis and epididymis, it seems probable that there is some communication not only between the arteries and veins, but also between the veins and arteries.* As is the case in the intestines, see above.[1] This has not indeed been hitherto observed, yet we may conjecture as much from the connection of things, in order, namely, that there may be no lack in the quantity of blood of good quality; and also from other signs, as from the circumstance that the little veins are more numerous and larger than the arteries, which would not be the case if all the venous blood without loss of time were drawn away to other parts; and moreover, from the fact that these veins are entirely without valves, so that the blood can always run back into these extreme parts, and be on hand

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[1] See 1 A. K., 134, note 1.

whenever the business and state demand. Thus the experiment of Leal Lealis seems to be readily reconcileable with the supposition that the blood passing into these venous vessels by injection through the arteries into the veins, might pass either from above or from below the corpus pyramidale. The blood of the better sort is, therefore, dispensed without any loss. But on these subjects more will be seen in the chapters on the Testicles and the Uterus. *One little artery communicates with another here, as in the body universally, whereby there is nothing proper to any one vessel, even the very least, that is not common to all. This also contributes to a most important extent to the quantity and quality of the blood. So, too, the little veins mutually intercommunicate.*[1]

19. [THIRD.] *Hence it follows that an ever new supply, and a fresh and greater abundance, flows in during the act, that is, during coition.* This must be the case if the veins communicate with the arteries close to the testes and epididymides, for otherwise a quantity of the viler blood might flow in, which would not only defile the seed, but would also burst the small vessels and capillaries. Furthermore, above this splitting of the vessels into threads, there seems to be a kind of reservoir, although extremely small; for below their origin the arteries are somewhat more swollen.

20. [FOURTH and FIFTH.] *That this blood be unimpeded, and thus be conveyed with certainty and by the safest way. This follows from the fact that it is brought thither not from a single origin but from several; also that the vessel applies itself to the peritoneum, adhering to it by little leaflike productions; and that after it has become the pampiniform body or corpus pyramidale, it is surrounded by a sheath or production of the peritoneum, whereinto the vessels do not pass stragglingly, but become adherent to the walls of the sheath.* Thus they proceed with the utmost protection and safety, fixed and completely attached to the peritoneum. *Moreover, lower down, they apply themselves to the pubic bone as to a fulcrum, before applying themselves to their respective organs.* This, indeed, is a provision of the utmost importance in the act of coition, when all the muscles both of the loins and thighs, and of the region under the diaphragm, and moreover the vertebral muscles, are in the fullest stretch of work and effort. At such a time, unless these vessels were defended by a common tunic, they might easily be exposed to mischief; but when a sufficiency of this kind of covering[1] is interposed to preserve them whole against all dangers, then none but a general action results to the peritoneum, and from the peritoneum to its production which encloses these capillary vessels; and then the action is not perilous, although consisting of the extraordinary actions of many muscles. *The general motion of the peritoneum also conspires to this end,—a motion which coincides with the respiratory motion, consequently with the motion of the nervous system both from its origin and in its progress. Wherefore, since the general motion of the blood, that is to say, of the arteries, accords with the motion of the nerves, so immunity attends the vessels.* That the motion of the peritoneum coincides with that of the lungs, see above, on the Peritoneum.[2] Moreover the fact is made plain to every one by the alternate movements of the respiration. In inspiration, all the muscles of the abdomen swell up, the lungs acting on the abdominal viscera by means of the diaphragm, and likewise on the peritoneum itself by means of the muscles. *Moreover the form of fluxion of the pampiniform vessels also concurs to the same end; for they make oval and spiral twists, as is the case everywhere with the minutest vessels which carry the purer blood, since this form of fluxion is suitable to the most perfect fluids, which when so determined, tend with safety and certainty to their destinations.* Respecting the form of this fluxion, see above throughout,[3] and also Transaction V on the Doctrine of Forms.[4] This form of fluxion is itself a sign of the purity of the fluid that runs through it; for it is by reason of their proper, natural, and, as it were, spontaneous fluid, that such forms flow into this kind of gyre.

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[1] These italicised words are written in the margin of the original manuscript.

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[1] The Latin is *humoris* (humor), for which we would suggest reading *laminæ*, as in the text.

[2] See 1 A. K. 312 *seq.*, and particularly 322, note c, 324, 396, note p. In the Latin this and the following sentence are put in italics.

[3] See 1 A. K. 97, 288.

[4] Transaction V, "Introduction to Rational Psychology," was to treat of: 1. The Cortical, Medullary and Nervous Substance. 2. The Arachnoid Tunic. 3. The Doctrine of Order and Degrees; 4. of Forms; 5. of Correspondences and Representations; 6. of Modifications. 7. Ontology. (3 *Doc.*, 925, see also below, n. 167.) This identifies Transaction V as the work on the FIBRE, which includes

21. *Moreover, the spermatic or seminal vessels, in their descent closely apply themselves, not only to the peritoneum, but also to the psoas muscle, and to the transverse muscle of the abdomen; and finally they pass through the aponeurotic ring of the oblique descending muscle.*[1] *The action of these muscles, if compared with the action of the lower part of the body during coition, coincides so marvellously with the position of these vessels that at this time the latter pour on more blood. For the action of these muscles then alternately opens and constricts, stretches and relaxes those vessels, so that they necessarily emulge a large supply of blood from their origins.* This may be specifically demonstrated, but for this we require a knowledge of the muscles and of their modes of action. The psoas muscle extends from the last dorsal and all the lumbar vertebræ at the back of the ileum, to the anterior part of the femur; it then strengthens itself with the iliac muscle.[2] Its action is to bend the femur upon the pelvis, drawing the latter forwards. Something similar to this occurs in the case of the abdominal muscles mentioned above. But to describe the act itself, and to deduce therefrom the suitableness [of the muscular action] would be tedious; it is also immodest, and so I pass it by.

22. *As to the venous blood, it undergoes nearly the like fortunes with the arterial. The impurer and grosser portion is discharged into the emulgents; but the better and finer portion is sent towards the smaller ramifications, namely, into the peritoneum and mesentery; and this, according to the successive origins of the veins from the spermatic arteries. The grosser parts are sent off first; and afterwards in regular order the purer.* The

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nos. 1, 2 and 4 of the above contents, as well as a treatise on Diseases of the Fibre. The Doctrine of Forms may be consulted in that work, n. 255, *seq.* Number 5 of the above mentioned contents of Transaction V is dealt with in the HIEROGLYPHIC KEY, and also in an unpublished MS. of nine pages (3 PHOT. Mss., 183–191). Number 7 is published as ONTOLOGY, which also deals with the subject of number 6, namely, the doctrine of Modifications.

[1] The external oblique.

[2] The psoas and iliac muscles are inserted into the lesser trochanter by a common tendon.

causes are similar to those that obtain in the arteries; for there is no determination of either artery or vein without an end in view. In the least of all her steps nature regards some end; and, therefore, the reason for each step may be searched out. But this subject does not belong to the present Transaction.

23. *From the foregoing considerations we may, in some slight degree, draw conclusions as to the causes of excessive salacity and prurience, and also of excessive chastity and of natural impotence; also as to the quality of the seed as arising from the excessive or the oversparing use of venery; and moreover, as to the state of the uterus and the state of the spermatic vessels during pregnancy; and as to many other subjects which are here suggested. But conclusions drawn from the spermatic vessels alone, can be formed only imperfectly; they will be more certain and better established when drawn from the several genital organs taken together. For the cause is deduced not simply from the spermatic vessels, but also from the state of the above mentioned organs. However, every change of state in the organs themselves redounds at last to these spermatic vessels.* As, for example, in pregnancy, when these vessels swell out to form sinuses as it were. They are, moreover, different in the two sexes respectively, running in women to the uterus and in males to the testes and epididymides; in our consideration of which organs, we desire to resume the thread here begun. *Meantime, in the salacious, the spermatic vessels are larger than usual, and spring from more numerous origins; the pampiniform vessels also are more numerous, complete, distinct and swollen, nor do they communicate so continuously with the veins above and below the corpus pyramidale; besides this, the blood is more abundant and is richer in spirit, as in the case of adolescents. Hence there is an accumulation of seed, and hence prurience.* Cases of salacity are plentiful and familiar enough. That the habitual use of venery excites an oft recurring prurience, is also a consequence following from the general rule previously laid down, namely, that use in the extremes commands both the quality and the quantity of the blood. Thus the practice of suckling results in a more abundant flow of milk; and the same rule is exhibited in innumerable other cases. See above [n. 13]. *On the other hand, when there is overmuch chastity, or a too sparing* *use of venery, the vessels become obliterated as it were, and emptied out; particularly the pampiniform vessels, which are kept open by use and temperate indulgence,—the flow of blood through them being then maintained, and the state renovated. In default of this temperate indulgence, the blood is discharged into the veins, and into other arteries,—for several places of discharge are provided; thus the spermatic vessels become unused to take their course, hence they become crammed with blood that is not pure, or their walls grow together, and, with diminishing calibre, they begin to perish.* Hence comes impotence, which may be either natural or acquired, and which may also arise from excess and over indulgence. In the latter case the vessels, being over-emptied, begin to collapse, or, being unduly turgid, at length become clogged, so that the more impure blood blocks up the pores of the testicles; for when the blood is deprived of its spirit, and still goes through these vessels time after time, the vessels themselves cannot fail to lose their natural state.

24. *On the same grounds also we may judge of the quality of the seed. For although the seed is elaborated in the testicles, yet the material from which it is elaborated is drawn from the spermatic vessels. In a word, in the matter of origin, both the quality of the seed and the state for the exercise of venery depend upon the balance of supply, plentiful or defective, of blood from the spermatic vessels, and above all from the pampiniform vessels in the corpus pyramidale. For here it is that the blood is purified which is afterwards prepared into seed. Therefore, the first seat and station of Venus is in the corpus pyramidale.* But from this point a spacious course and field lies open; here is only her first starting point, from which a long course must be traversed before the goal is reached and the game terminated.

CHAPTER II.

THE TESTICLES, EPIDIDYMIDES, ETC.

25. **WINSLOW.** (*Expos. Anat.*) The ancients called the testes, didymi, or twins. They are about the size of a pigeon's egg, of an oval shape, but a little flattened on each side.[1] At the upper edge each has a kind of appendix, called the epididymis, together with which the testicle is involved in several coverings; and both testicles are suspended in a common covering called the scrotum. Each testicle is a spermatic gland consisting of a great number of fine whitish tubes, folded and twisted in different ways and distributed in different fasciculi between membranous septa, the whole being surrounded by a common covering named tunica albuginea. These septa are disposed longitudinally, so that they approach each other on one side and divaricate on the other. They approach each other along one edge of the testicle, where they terminate in a long narrow whitish body, as in a kind of axis. This body may be called the node of the testicle. From thence they divaricate in a symmetrical manner, and are attached by their opposite edges to the inner surface of the tunica albuginea, of which they appear to be a continuation. From this description we see that these septa are not all of equal breadth; that the intervals between them are in some measure triangular; and that the extent of the small tubes which lie therein must be very considerable. They have been reckoned to amount to many ells by taking the sum of their several portions. They may be unfolded by a long maceration, which, however, destroys the delicate substance by which all their winding folds or convolutions are colligated. All these canals appear to terminate by a few common trunks at the node or white body mentioned above; which trunks afterwards pierce the upper part of the anterior extremity of the testicle, and are disposed

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[1] See Plate II.

in several folds along the lateral external part of the upper edge all the way to the posterior extremity. From this union arises a long whitish plaited fasciculus, called the epididymis. (*Tr. du Bas Ventre*, n. 482–488.)

26. The epididymis is a production or process of the testicle, or a kind of accessory testicle. It is not of equal volume throughout, being more contracted in the middle than at the extremities, by which it is closely attached to the extremities of the testicles. In the interval between its extremities it does not immediately touch the testicle, but is loosely attached thereto by the duplicature of a very fine and almost transparent membrane which serves as a kind of ligament. This membrane is the continuation and duplicature of the tunica albuginea, which, having supplied the place of a ligament to the epididymis, afterwards invests it. The epididymis is flat, slightly concave on the under side, or that next the testicle, irregularly convex on the upper side, or that turned from the testicle, and these two sides are distinguished by two angular borders. By the inner border it is attached to the testicle in the manner already mentioned; the outer border is free. The anterior extremity or head of the epididymis arises from the testicle; the posterior extremity or tail adheres very closely to the testicle, and gradually contracting, forms a particular canal called the vas deferens. (*Tr. du Bas Ventre*, n. 489–492.)

27. The tunics or coverings of the testicles are three in number: the muscular tunic, named cremaster, the tunica vaginalis, and the tunica albuginea. The first two are common to the testicle and the spermatic cord, but the third is proper to the testicle alone. The tunica vaginalis is the most considerable of the three. It is a continuation of the sheath of the spermatic cord. This sheath in its descent towards the testicle appears to divide into two layers, the inner of which forms the bottom of the sheath, and the outer expands round the testicle, bestowing upon it a coat called tunica vaginalis, from the Latin word *vagina* (a sheath). The ancients termed it elytroides, from a Greek word that signifies the same thing. The inner surface of this tunic is lined by a fine membrane which strengthens the bottom of the sheath and forms a kind of diaphragm which prevents all communication between the sheath of the spermatic cord and the tunica vaginalis of the testicle. The cremaster is a thin muscle, or fleshy plane, which runs down round the sheath of the spermatic cord and terminates in the tunica vaginalis. It surrounds almost the whole of the tunic, and afterwards spreads out on its upper and outer part, where it is inserted and lost. It arises partly from the ligament of Fallopius,[1] and partly from the lower edge of the internal oblique muscle of the abdomen; and on this account it seems sometimes to arise from the spine of the os ileum. It is covered by a very fine cellular membrane detached from the outside of the aponeurosis of the external oblique muscle round the opening called the ring. This membrane is lost in the cellular substance of the internal surface of the dartos. This muscle is not always red. (*Tr. du Bas Ventre*, 513–522.)

28. There are two particular nerves that accompany the spermatic cord; one comes from the lumbar nerves near the anterior spine of the os ileum; it makes a curve before running out of the abdomen through the muscles, and in its passage serves to distinguish the cremaster. The other of these two nerves comes from the renal plexus.[2] (*Ibid.*, n. 587.)

29. HEISTER. (*Compend. Anat.*) The testicles or didymi. Their coats are three: the cremaster or elevator muscle of the testicle; the tunica vaginalis, loosely surrounding the testicle, and derived from a process of the peritoneum; the tunica albuginea, strong, closely connected with the substance of the testicle, and receiving the spermatic vessels and transmitting them to the testicle. The nerves are from the plexuses of the nerves of the pelvis, and from the lumbar plexuses. Their lymphatics may be seen in the living animal in great abundance. Their substance is vascular, consisting of the most minute vessels, called the seminal vessels and convoluted after the manner of intestines. No glands are to be seen in the testicles. The corpus Highmori in the human subject is at the back of the testis, but in the dog, in the middle part; it is said to have a cavity for receiving the seed. (n. 224.)

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[1] Poupart's ligament.

[2] Thus in Winslow, but our author has here "mesenteric plexus." See Plate VIII.

30. The two epididymides or parastatæ are longish, almost cylindrical parts lying on the upper border of the testicle, and each having the appearance of a caterpillar or silkworm. They are connected with the testis and also with the vas deferens, by the membrana albuginea. They begin in the testis by five or six small seminal vessels. They end at the other extermity where the vas deferens begins. They are covered by a robust membrane continuous with the tunica albuginea. They are of a vascular substance like the testes, but consisting of vessels that are not only very conspicuous, but whose tubular nature is plainly shown by injections. All these vessels end at last in a single duct called the vas deferens. The blood vessels of the epididymides are the spermatics [which also supply the testes]. Their nerves are from the same branches as the nerves of the testes. (n. 224–225.)

31. That the substance of the testicles is vascular, is affirmed by Arantius, Cabrolius, Riolan, De Graaf, and Morgagni. This vascular substance is well seen in the tortoise, the pig, the goat and the dormouse. (Nota, 25.)

32. BOERHAAVE. (*Instit. Med.*) The cremaster muscle draws up, sustains, compresses and expresses[1] the tunica vaginalis and the testicle. The seminal artery near the testicle gives a branch to the lower and inner part of the epididymis, which branch spends certain twigs on the testicle itself, and afterwards terminates on the nervous tunic. [Sometimes also the artery sends another branch to the top of the testicle, and] constantly a large branch to the upper and bulkier part of the epididymis [where it ramifies and is distributed in all directions]; not to mention numerous offsets from the larger trunk, closely interwoven and communicant with the little veins in the corpus pyramidale, and afterwards spread over the compass of the testicle. (n. 641–642.) These arteries, penetrating the nervous coat, gradually divide into branches, and taking up distinct places, finally spilt up into numberless twigs, and these into the finest capillaries which seem to the sight to be infinite in number occupying almost the whole of the testicle. They have no corresponding veins. (n. 644.) [The testicle has also minute veins and innumerable lymphatics, which bring back from the body of the testicle the humor that remains after the seed has been secreted; and it seems probable that when the seed is prepared in the testicles and not evacuated] a considerable and subtle portion of it is reabsorbed by these vessels, and mixed with the venous blood in the corpus pyramidale. (n. 647.)

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[1] i. e. Squeezes out the juices from.

33. Morgagni. (*Adversaria Anatomica.*) On one occasion, whilst I was gently drawing away the epididymides of the land tortoise from the testicles (which appeared to me, differently from what other authors describe, to be made up, not of round glands, but of the finest convoluted vessels), I saw up against the light minute and pellucid vessels passing straight from the whole side of the testicle to the side of the epididymis; and from that time I suspected that seminal tubules issued from the middle of the testicle as well. (IV, § 2, p. 4.)

34. Schurig. (*Spermatologia.*) Many instances are recorded of castrated persons experiencing lust, and shedding large quantities of seed. (IX, § 4.) Ruysch says that the substance of the testicle consists of nothing but various fascicles of vessels of a blue color. Instances are given of cartilaginous and osseous testicles. In some subjects only a single testicle has been found; such persons are called monorchides. In some, one testicle lies in the groin, the other in the scrotum. Sometimes, as a result of disease, one testicle is drawn up from the scrotum into the groin or abdomen. (II, § 11–16.) In some subjects the two testicles coalesce, in others both testicles are absent; this is sometimes congenital, sometimes the result of gangrene, violent accidents, surgical operations, and castration. In some persons three, four or five testicles have been found; and the same in animals. (II, § 19–25.) The left testicle is commonly the larger of the two. There are found large testicles of various size and mass. Cases are recorded of testicles of extraordinary bulk; and also of uncommon smallness. Calculi are also now and then found in the testicles. (II, § 27–30.)

35. Vieussens, in his *Neurographia Universalis,* Plate XXIX, shows the fourth nerve of the sacrum giving off branches to the muscles of the anus and to the gluteus major; but the main trunk, [the pudic nerve,] runs finally to the [gen-

eral and particular tunic of the] testes. During its course, this fourth sacral nerve forms two unions; first with a branch of the third sacral, and then a lengthened unition with the nerve, [the dorsalis penis,] which runs from the middle of the [posterior] crural nerve,[1] and is distributed particularly to the penis and its muscles. Lower down a branch [the small sciatic] of the [posterior] crural nerve goes to the scrotum.[2]

35a. [De Graaf. (*De Virorum Organis Generat. Inserv.*) We are of the opinion that the seed may be made up from the blood by one of two ways. Either the spermatic arteries are continuous with the seminal tubules; or, they lay down in the cavity of the latter their more subtle matter and return the grosser by way of the veins. The former is not the way in which the seed is made up, since the arteries are ten times smaller than the tubules,—an evident sign that the latter do not come from the former. Moreover, if the arteries were continuous with the tubules we should necessarily find in the beginning of the latter, or in the extremity of the former, a reddish fluid turning to white,—which, however, is not the case. In a large dormouse the spermatic artery goes under the tunica albuginea from the posterior part of the testicle to its anterior part, when, leaving the tunic, it is divided up into many branches which run in all directions and embrace the tubules by almost invisible ramifications, but in no way constitute them. Since then the generation of the seed from the blood cannot be effected in this way, it must be effected in the second way; that is, the spermatic arteries lay down their matter in the tubules just as the hepatic arteries, which in like manner enfold the hepatic ducts in their embrace, unload the material of the bile into the cavity of the ducts. (In Mangetus, *Bib. Anat.*, I, p. 567.)]

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[1] Posterior crural nerve, called also the great crural, is the name formerly sometimes given to the great sciatic, to distinguish it from the anterior crural,—the latter being distributed to the anterior portions of the thigh and leg, and the former to the posterior portions. The name "anterior crural" is still retained as a designation of the femoral nerve, but the term "posterior crural" is no longer in use.

[2] Vieussens' Plate, which is reproduced in the present work, Plate X, shows the great sciatic as formed of the fifth lumbar and first, second and third sacral. The fourth sacral is shown as making a brief contact with the main stem of the third (see n. 63, note), and then being distributed to the perineum, penis and testis. Going off from the great sciatic is shown a nerve which makes a long contact with the fourth sacral and is then distributed to the perineum and penis. According to modern diagrams, the fibres of these two nerves,—the fourth sacral and the branch of the sciatic,—come together to form, with other fibres, the pudic nerve, of which the dorsalis penis is a considerable branch. Still further down in Vieussens' figure the sciatic gives off a branch [the small sciatic], made up of fibres of the second and third sacral. This branch then divides into two nerves, one of which [the inferior pudendal] is distributed to the scrotum. The three nerves referred to in the text are, therefore, 1. The fourth sacral, with fibres from the third [and also the second, see n. 140] sacral, going as the pudic nerve to the testes, etc. 2. Fibres from the great sciatic, running into the pudic nerve, from which they afterwards separate as the dorsalis penis. 3. The inferior pudendal branch of the small sciatic.

The reader should bear in mind that nerve fibres, unlike blood-vessels, never actually divide or unite with other fibres, see n. 278. When, therefore, a nerve is said to give off a branch, what is meant is that some of the fibres separate to form a new nerve or to enter a sheath of some other nerve; the latter being the case when one nerve "makes a contact" with another.

35b. [RUYSCH. (*Thesaurus Anatomicus.*) The spermatic vessels which creep through the testicles run by their little trunks through the interstices of the seminal tubules and bestow their lateral offshoots upon these tubules with which I suspect they are united. Indeed, I am of the opinion that the ultimate extremities of the arterioles degenerate or are changed into the said seminal vessels. (IV, n. 8.)]

INDUCTION.

36. *It is commonly believed that the testes are the only organs that prepare the seed; this, however, arises from not knowing what the seed is, or the essences of which it consists. The seed is not a humor of simple composition, but a humor compounded in regular order and succession; first of the inmost and purest substances, next of substances less simple and pure, and lastly of outmost substances, which, with due prudence, involve and store up the inmost, and this in such a way that in the uterus the inmost substances are again evolved and unsheathed in almost the same order as that of their involution. The inmost substances that lie in the seed are by no means visible to our eyes, but they show and declare themselves by their effect. Even the outmost are scarcely apparent in their details except under the microscope; and this instrument, however high its power, hardly touches anything but the mere surface of parts that are infinite in number.* To this end it is, that so many organs are constructed for preparing this single humor, to wit, the testicles, epididymides, vesiculæ seminales, prostates, and also the urethra with its glands; every one of which organs contributes its share. These organs must be treated of in regular succession; and afterwards be reconciled with the nature and faculty of the seed itself.

37. *The inmost essence of the seed, which is the inmost essence of the man or other animal and which is, therefore, partaker of life, is not prepared in the testicles, but is drawn out in abundance from the blood and from the juice of the nervous fibres. Thus the testicles are organs that extract and supply the inmost essence of the seed, which is the sole essence that makes over to the future offspring its principles and commencements. Hence without the testicles there may indeed be seed,—possibly, in external garb, similar to genuine seed,—but it is not prolific.* This is evident enough from cases where the testicles have been lost, either by castration, accident, or disease such as gangrene and the like. In such cases, although all the other organs may remain and may suffice to pour out seed, even in large quantities, still such seed is not prolific or fruitful. The humor that springs from the testicles is never presented when it comes to action, but only that which is extracted later in the vesiculæ seminales, the prostate, and from the glands of the urethra, the humor of which organs has all the appearance of seed. *The inmost element in any humor or in any part thereof is that which must first be supplied in order that the other elements in succession may perfect the work. This inmost element must be enveloped in kindly and most suitable essences; for that which is inmost is likewise purest, and unless at once and at the very outset, it be encased in other and less volatile essences, it is easily dissipated, and, the principal cause thus vanishing away, the primary effect itself comes to naught.* This inmost and first essence of every animal kingdom is so highly volatile that unless it were immediately imprisoned by other and more fixed elements it would at once fly away; on which subject see our psychological transactions. And when it has flown off or vanished, still the humor left behind appears the same to the eye; like the surfaces and membranes of the brain when the cortical substances and the fibres have been eaten away; or like a nut when the kernel is gone; and like all other things where only crust remains. *Nature, therefore, in order that she may set out from inmosts, sets out from the testicles, which supply the inmosts.* This becomes clearly evident from the mode of these organs; for their very structure convinces us that they supply an abundance of the purest essence.

38. *If the structure of the testicle be well examined it will be evident that it is so wonderfully constructed on geometrical principles that nothing can be more perfect. For the capillaceous vessels or minute tubules which form its texture, run in such tortuous convolutions, after the manner of intestines, that they aspire to a form and to determinations superior in perfection to the circle. These several vessels, thus co-ordinated, are connected together by the finest bonds, so that there is no least one of them which in any individual effort does not have regard to the general, and, in due succession, to things more general, and finally to things most general. These exquisitely fine or individual bonds of the* *vessels, unite together to form more general partitions or septa; these septa again coalesce into one most general tunic, called the tunica albuginea. Thus there is no part of the testicle, howsoever minute, but stands related in regular order to the general membrane. This membrane again, from all its points, looks to a certain common axis, which is the node at one side of the testis and is called the Corpus Highmori. This axis, being a congeries of centers disposed in the manner of an axis, looks to its focus or extremity as the common center of all the determinations; that is to say, to the prostates or epididymides. Thus by the mere force of form all the single tubules of the universal testis respect the epididymis as their terminal goal whither they direct their essences, previously poured into more capacious tubes or canals, in the most exact manner. Thus the testicle, which by virtue of its very form is held in the utmost safety, performs all the functions for which it is designed, in just manner, and, as it were, with spontaneous determination. In the human testis this axis is placed at one side, almost outside the sphere, but not so in the testis of the dog. This is in order that the two testes, though disjoined, may still in a manner represent a one. For when each testis determines itself towards the surface to an axis, and both axes are represented as united or as one single axis, then this latter stands in place of a center, and both testes regard one origin, that is, one corpus pyramidale or one spermatic vessel.* These points being plain from anatomy, and geometrically demonstrable, I shall say no more about them.[1]

39. *This wonderful reference of the parts to their general is exhibited in each of the testes. All this reference, however, or all this determination, is proper to the testis itself, inasmuch as the whole of the structure enclosed in the tunica albuginea belongs properly to the testis. The vessels and fibres are indeed continued from the vessels and fibres of the body, but in such way that when they enter the body of their testis, they then no longer belong to the body, but to that new authority or province whereto they have been assigned. For they are disjoined from the other provinces of the body, or rather from its regions; that is to say, they are disjoined from the body by a kind of partition, not unlike the dia-*

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[1] In the Latin this sentence is put in italics.

phragm, which is placed in front of them transversely, just under the corpus pyramidale, and is connected on the one side of the membrane with the inmost tunic of the corpus pyramidale or production of the peritoneum, and on the other with the inmost membrane of the tunica vaginalis; very much as the great diaphragm partitions off the epigastric and hypogastric regions of the body. By this means the vessels and nerves that enter the tunica albuginea are exempted from the body's sway, and are brought under hat of the testicle. Moreover, in order that the testicle may not be a part wholly discriminated and separated from the common stock, but may be continued therefrom in a general manner, the peritoneum descends all the way to the testis, and clothes it over with a tunic borrowed from and continuous with itself; hence the tunica vaginalis, which is a continuation of the peritoneum and consequently of all the abdominal viscera enclosed in the peritoneum. And at the same time, in order that the testis may depend upon the body in a most general manner and be subject to its motion, it is still further covered by a motive or muscular tunic continued from the tegument of the body, namely, by the cremaster muscle, which is extended from the oblique muscle,[1] *as well as from its aponeurotic substance, from the corpus pyramidale or spermatic cord, and over the anterior part of the testicle. Thus it is kept in the same general stream of motion as the abdominal muscles, and hence in the pulmonic motion. In this respect, however, the testicle is only the common appendage of the lower region of the body. That it may be also the common appendage of the whole body, it is girded about with the dartos, bursa or scrotum, of which we shall treat specifically further on.* The simple statement of these particulars makes it evident how nature unites together the parts and viscera of the animal frame, and also their provinces and regions; and at the same time distinguishes and separates them. For whatever part is not continued to the general or from the general, is no proper part of this kingdom. But still it is continued in such way that it is, nevertheless, a member that possesses its own property and belongings. To look into all these matters distinctly would require many pages; but as they are superficial and formal, and do not specifically concern the preparation of the seed, I do not dwell on them longer, more particularly since a similar rule of arrangement is found everywhere in the body.

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[1] The internal oblique

40. *With regard to the alchemical preparation of the seed in the testicle, it is a matter most difficult of intellectual apprehension; for it presupposes a knowledge of many subjects, which for the sake of orderly progression it would not be proper to explain at present. It presupposes that we know what the soul is, what the animal spirit, and what the blood,—all of which enter into the composition of the seed. For before we can know how the soul of the parent, and, in like manner, the whole faculty of growing into a corresponding body, passes over into the future offspring, we most certainly require a knowledge of the nature and faculty of the first substance, which is the very formative or creative plastic substance of the new embryonic body, and which in the purest sphere of things, represents in the most perfect manner all that which exists in the great sphere, and which is to exist in the new being. But as we must advance and mount analytically, that is to say, from effects to things prior, or to causes and principles, so I am necessarily bound to set forth here at the threshold certain particulars which will not become clear until we return to them in the sequel and come at last to knowledge. In the meantime let the end crown the work.* Since I have already treated of the blood, I will here only repeat that it is the complex of all the essences possible in the body; that is to say, it not only consists of numerous elements and principles from the elemental world, but moreover, its inmost essence is the animal spirit, and the inmost of this is the soul itself which is the first and the proper substance of its body from which and for which all the rest exist.

41. *In order that the seed may be so prepared that it can serve for the formation of a new body and a new life, it is necessary that the inmost, purest, simplest or supreme essence of the parent himself be put into it. This essence indeed is allotted the inmost place in the seed, so that each part of the seed* (genitura) *lays up within itself deeply and inmostly that which is purest and supreme. In order to bring this about, the latter must needs be drawn out from the blood and nervous juice in the first organ, which is the testicle; and then gradually, in the succeeding organs,* *be enveloped or enclosed in other elemental substances to prevent its flying off into aura and to bring it without fail into use. Thus it is that the principal essence extracted in the testicle is afterwards enwrapped in a regular series of envelopes in the parastatæ*[1] *and vesiculæ seminales, yea in the prostates, and even in the urethra. This is now to be shown, and in the first place, that the testicles pour on the true vital essence, which is the veriest plastic substance. For although seed is produced without the testicles, such seed is not prolific; as is abundantly shown by cases where the testicles have been cut away, injured, rotted, ossified or weakened by old age.* This is the sum of our treatise. For the seed which is visible to the eye is not immediately produced by the testicles, but something is ever being added to it in the other organs. Certainly the inmost and vital part is absent if the testicles are wanting. That the seed may be built up from its first principles these must perforce be poured into it in the first organ, that is, in the testicle. That which is inmost must be first in the series of all that follows. Hence the function of the testicle becomes evident,—a function that will be seen in still clearer light after consideration of the structure of the testicle, and of the infusion of this essence. With respect to those cases in which prolification has taken place after removal of the testicles, they will be explained in what follows, especially when we treat of the vesiculæ seminales.

42. *The canals or intestinal tubes of which the substance of the testicles is made up are nothing but continuations of the finest vessels from the spermatic arteries.* This is shown by the experience of many anatomists, as Ruysch, Morgagni, De Graaf, and Heister. These vessels pass into the testicle through its proper coat, the tunica albuginea. *Besides these vessels, continued as above and circling about in wonderful windings, there also flow in immense multitudes of nervous fibres, which, according to the custom observed in every part of the organic frame, flow into all vessels, large, small and smallest; hence in the testicle they flow into all the several canals, which, if we may judge from the multitude of nervous fibres, they completely envelop, bestowing upon them a kind of new tunic.* That the nervous fibres in the body flow almost without exception into the blood vessels, has been demonstrated by many considerations in Transactions I and II. For in order that the fibres may build up the organic machine of the body,—and this must be built up principally from the blood vessels,—it is necessary that they closely apply themselves to these vessels; hence the nervous coat of the latter and the other coats, which in fact are constructed of none other than nervous principles. For in the organic body the sole thing that rules is the fibre, which, in descending by degrees and forming its organism, essays in the first place to inform[1] the sanguineous canals; as may be seen demonstrated in the Treatise on the Fibre.[2] Especially is this the case in the testicle, which is entered by multitudes of fibres; for fibres come in from the mesenteric plexus,[3] and consequently from the par vagum[4] and great intercostal nerve,[5] which accompany the spermatic vessels; also from the lumbar nerves,[6] then again from the great ischiatic and the [posterior] crural nerve; and moreover a large branch from the fourth pair of sacral nerves, as will be shown below.

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[1] Another name for the epididymides.

43. *As such a quantity of nervous fibre flows into the testicles, closely applying itself to each tubule thereof, it follows that this fibre pours in its spirit or noblest essence immediately; and indeed the very essence that is contained in the compound, and thus in the most simple fibres.* That the fibre applies itself to the vessels, is plain to be seen in all the viscera of the body, as in the spleen, lungs, brain, and also in the several costal vessels, which the fibre binds around like ivy; see above [n. 42], and the Transaction on the Brain. And since in the testicle the fibre winds around every tubule, and completely opens out or unfolds,—for it inflows in sufficient quantity to enable it to unfold,—it follows that each and every simple fibre, thus unfolded and terminated, pours in its essence, which is the inmost and first of all. That the nervous fibres pour their spirit into the blood vessels exclusively, to the end that the blood may be impregnated therefrom and be constituted the humor that plays the soul's part in the body, see Transaction I [n. 151–153] and the Transaction on the Fibre.[1] *It is, therefore, the fibre that puts the first essence of the seed immediately into the tubules, and in fact supplies that which is the vital essence, that is to say, life itself and the principles and commencements of bodily life. This alone it is that can be called the plastic and prolific essence and the very principal of all; the rest, however, exist on its account, in order that it may be rightly gathered into its form and may commence the web of the animal body.* The nature of this substance, force, or essence will be seen in the Transactions on the Animal Spirit[2] and the Soul.[3] It is established beyond chance of doubt that the soul which is carried over into the offspring lies in the seed and is not poured in at a period subsequent to impregnation. For unless this were the case, surely the female might conceive, even though the testicles of the male were removed or the seed depraved, merely from the sprinkling of some seminal substance, that is, of a substance emulating seed.

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[1] That is, form from within.

[2] See the FIBRE, n. 314 *seq.* It should be noted that by the term "fibre," when used without any qualifying word, is meant the medullary fibre of the brain emitted from the cortical glands (*Periosteum*, n. 4). A distinction is made between this and the nervous fibre of the body, the two being called, respectively, "medullary" and "nervous" fibre (n. 145), "fibre" and "nervous fibre" (n. 42, *Periost.*, n. 7); "least fibre" and "nervous fibre" (n. 91); and "fibril" and "nervous fibre" (n. 313). See Index, s. v. *Fibre*.

[3] See Plate VIII.

[4] The Pneumogastric, see n. 44, note.

[5] The great sympathetic. The name "intercostal" is now confined to the nerves that run between the ribs; but formerly the sympathetic was so called because during part of its course it runs from rib to rib, as it were.

[6] See Plate IX.

44. *How great is the abundance of this essence which is poured into the testicles by the simplest nerves,*[4] *is clear merely from an examination of the influent nerve. For fibres are supplied thither, not only from the intercostal and par vagum, but also from the lumbar and the great crural or ischiatic nerves; and moreover, a particular branch comes in from the sacral plexus. Thus the supply comes from those nerves that carry the largest amount of*

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[1] See the FIBRE, n. 84–86, 303, 326.

[2] See n. 10, note, and consult the little work on the ANIMAL SPIRIT, particularly Chapters IV, VIII, X.

[3] See RATIONAL PSYCHOLOGY, n. 1—4, and also the FIBRE, n. 249 *seq.*, 274 *seq.*

[4] That is, the simplest fibrillæ into which the fibre is unfolded in the testes.

essence. The intercostal and par vagum or eighth pair of nerves,[1] are the largest and most general nerves of the body; after which comes the ischiatic, which is the largest of all the trunks. In addition to these there is that peculiar nerve [the pudic] from the sacrum, which Vieussens figures and demonstrates in his *Neurographia* [n. 35]. *If we well examine these several nerves it will be quite evident that all the fibre that flows into the testicles descends, not from the medulla of the cerebrum, but from that of the cerebellum; hence that this inmost and vital essence of the seed owes its origin to the cerebellum and not to the cerebrum.* That the intercostal nerve and the eighth pair, or par vagum, are nerves of the cerebellum and not of the cerebrum, see Transaction I [n. 478–479, 485 *seq.*]; the ancient anatomists, with Hippocrates, were aware of this fact. The same judgment may be made with respect to the nerve from the sacrum, delineated by Vieussens (*Neurographia, tab.* XXIX, n. 14–15)[2] and which runs to the testis. For, at the end of the spinal canal, what finally issues forth into the sacrum, is the whole residual fibre of the cerebellum; see the Transaction on the Brain and Medulla Spinalis. A nerve, moreover, proceeds from the great crural and closely applies itself to the nerve issuing from the sacrum, and after a long contact therewith, finally leaves it. It is a doubtful point whether this nerve is a nerve of the cerebrum or of the cerebellum, for the great ischiatic nerve, which springs from the lumbar nerves, is spent on the muscles of the loins, legs and feet, and, therefore, belongs to the cerebrum. But it does not run directly to the testicles, but comes in contact with a nerve that is determined thither and afterwards leaves it; so that it does nothing more than communicate the abundant spirit which it carries. Besides which a part of the fibres of the cerebellum also goes to form the above mentioned great crural nerve. Moreover the fact that the fibre of the testicle comes from the cerebellum is confirmed by the very effect, for the testicles are in no wise subject to the dominion of the will and cannot be called into activity at the will or disposal of the cerebrum,—their excitation arising entirely from a kind of natural spontaneity and instinct. Furthermore, if the conception of this seed (*genitura*), and of its first virtue, depended on the will, that is, on the cerebrum, all this faculty would go to wreck after the briefest exercise and the very purpose of nature would be wholly frustrated in the earliest age. It follows then, from the fibres themselves, and also from the effect, and finally from rational considerations, that the cerebellum is the butler and steward of the inner seminal essence.

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[1] The "eighth pair" of Willis is now distinguished into three nerves, the ninth, tenth, and eleventh, of which the tenth is the main constituent of the vagus or pneumogastric nerve.

[2] See this figure in Plate X. In Vieussens' work the nerve from the fourth sacral is marked "14" at the place of its "long contact" with the branch from the sciatic, and "15" at its various terminations.

45. *Whilst the love venery is proceeding from the first effort to the final act, and when at last it grows hot, so sweet a tremble and so bland a soothing seizes upon the whole nervous system, that all the fibres whatever in the brain, and all whatever in the body, expand in every way from inmost delights, and open up every path for the escape of the spirit. So much so that they are in the endeavor to prodigally lavish forth their whole spirituous treasure, wherever a way of exit is open; and especially into the arterial blood and the testicles, wherein the largest nerves terminate by their ultimate fibres. Hence the lassitude that follows venery, and the debility felt in the joints and muscles, particularly those of the loins, thighs, legs, feet and soles, after the excessive exhaustion of the nerves.* That the delicious affection called venery produces the effect of expanding the several nervous fibres, may be clearly enough evident from the actual phenomena. For the pores everywhere stand open; the animus is inmostly exhilarated and is in the desire to communicate to the other all its most precious possessions. Delight (*lætitia*) naturally expands the nervous fibres; how much more so this inmost delight, which far surpasses all others! The highly pure tremiscence; and thus, necessarily, the fibre that terminates in the testicles, evidences the same thing. This is abundantly demonstrated by the effect itself; for at this time the whole of the better animal essence rushes from those great nerves, the intercostal and par vagum, and also from the crural nerve, into the testicles; whence arises debility of the parts dependent upon the crural nerve, and also universal lassitude in the whole nervous system. This, however, does not arise from the quantity of spirit that flows out in the seed (*genitura*), but from that which runs forth everywhere else in the body into the blood and glands. Hence the fibres, everywhere deprived of their juice, must needs experience a kind of lovely swoon. But they are soon restored. For the spirit of the blood reverts back again to the fibres through the universal circle, that is, the circle of life. Respecting this circle of life, see Transactions I and II, and also the following Transactions, IV and V.[1]

46. *Thus the love venery, and particularly its act, is as it were, an effort to transcribe its whole life or vital essence into another self, or into the offspring,—so that it seems desirous of transfusing its whole life into the new life of a distinct being. And as this love springs from inmosts, the act itself expands the most simple fibres which contain and carry the first essence of the animal spirits; and this essence they breathe out, not only into the testicles, but also into the blood; for the blood has the task of conceiving and preparing the other elements that belong to the seed.* That the love venery proceeds from inmosts and expands the simple fibres, may be evident from the actual effect of this love; for it is of an ineffable nature, exceeding every external delight, and proceeding from the inmost. That there is an endeavor to transfuse the whole of the vital essence into another being, is evident from the parental love or storge, which begins naturally in the act; for we love and yearn towards our offspring as towards ourselves, and more than ourselves,—so much so that whatever in us lies, we long to pour forth into our progeny. But the wisest care is taken lest the effort should succeed and all our life be shed away, as happens in certain living creatures, and notably in the silkworm. *For these exercises, the time of adolescence and early manhood is the fittest; for at this period the simple fibres are naturally swollen with abounding spirit, but this is not the case as age comes on.* The fibres of adolescents are excellently distinct, apt for agitation in every detail, not as yet glued together; moreover the spirit comes in from its sources in generous abundance, and the blood also abounds therewith. Hence at the very first idea and contemplation of the object, the fibre and blood are most prone; for the loss of the spirit is then easily repaired, but not so in older people.

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[1] For the contents of these Transactions, see the Preface.

47. *The cerebellum particularly is in the highest stretch of effort and work, for it is from the cerebellum as from a fountain that the life of the seed is derived; and, therefore, since the cerebellum is put into this state, it spends all the wealth of its spirit on the fibres that provide for the genital members, and thus robs the other organs of their essences. Hence arises, as from a universal origin, that lassitude which is sometimes felt after the act.* This follows from the connection of things and also from the effect. For after repeated acts and the great ardor that has been then experienced, all parts of the body covet rest; and this is still more the case in those who pour forth a large quantity of seed, and in those who are of a more advanced age. Lest such lassitude continually occupy the nervous system and the brain, reservoirs, that is to say, the vesiculæ seminales, are provided (of which below), which are to be regarded as emunctories of the accumulated seed. Thus the abundant flow of seed is not always produced immediately from the fibres. It is further to be observed that the great crural nerve gives off from the middle of its body a particular branch which it brings into close contact with the nerve sent to the testes from the fourth pair of sacral nerves; see Vieussens, *Neurographia*, tab. XXIX.[1] This gives ground to conjecture that this nerve, by its connection with the nerve of the testicle, pours on a copious essence derived from the body or belly of the great crural nerve,—and this in order that the testicle, maintained from so generous a source, may never lack supplies. Especially is this the case, since, during the act, this nerve, the biggest in the body, is in full work and motion, and lavishes all its forces,—so much so, that it might rightly be called the venereal nerve.

48. *From the tunic proper to the testes, namely the tunica albuginea which is principally a nervous tunic and which ultimately subdivides into septa, all those nervous fibres pass into the several tubules or canals, which latter, although they are* [*separate*] *canals, are nevertheless continuations of the blood vessels. Thus these*

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[1] See Plate X.

canals are so surrounded on every side by nervous membranes that the blood flows into continuations which consist of nervous tubes. The tunica albuginea is also called a nervous tunic by Boerhaave as well as by other writers. That this tunic affords a passage through the septa into the several tubules, see above [n. 25, 32]. *But although the principal essence of the seed flows from the nervous fibres into these little canals, yet this does not hinder the soft and most genuine blood, but which has now undergone division into its constituent parts, and even into its animal spirit,—that is to say, the white blood, as it is called,—from running up into the same tubules; for this soft blood contains an abundance of similar essence, but enveloped in the purest elements and principles of the elemental world.* That the blood also contains an essence of this kind, which is its principal essence, see Transactions I and II, and also the succeeding Transaction, on the Brain, and indeed our treatises throughout. Hence the blood also brings in this essence. *But because this blood contains that purest seminal essence already enveloped in parts belonging to the elemental world and not, therefore, pure or perfectly free from earthly dregs, therefore, it is sparingly supplied to the testes, and indeed only in sufficient quantity to enable it to hseve for the reduction of that purest essence to its least forms, and for surrounding it with a kind of exquisitely fine membrane. Trus the pure essence forms a sort of inmost nucleus; and in order to the discrimination of this nucleus from its fellow nuclei, the blood with its elements must contribute supplies.* This cannot be made wholly clear to the intellectual apprehension until I have entered upon a description of the parts of the seed. But let it be premised that the vitality of the seed requires that it shall inmostly enclose in its every part the above mentioned purest essence. In the blood this essence is not pure, nor is it kept in a nucleus but is tied and bound up with the purest principles of the elemental world, whence springs the animal spirit. So long as this essence is thus enveloped, and not pure, that is, not left to itself, it cannot possibly set about the formation of a new body. The testicles, therefore, are provided to the end that this pure essence may flow in immediately from the fibres, and that only such quantity of the blood or of its animal spirits shall flow in as shall suffice to inmostly enclose this essence, like a nucleus in a very fine shell. It is for this reason that seed cannot be prepared merely from blood. *This is the reason why there is not so great a quantity of arteries supplied to the testes as to the parastatæ or epididymides. For the animal spirit proceeds solely from compound fibres and their canals, and also from the resolved blood; but the true first essence of the spirits only from simple fibres, of which the compound are made up.* But on these points see the treatises on the Fibres, the Animal Spirit and the Soul,[1] for unless these be well understood, what we have set down will be a foreign tongue.

49. *The mere length and tortuousity of the canals mainly contributes to all being carried on in a proper manner and according to the order instituted by nature. For through the long and highly subtle tubes none but the purer part of the blood can be driven—that part namely, which is agreeable to the nature and elastic force of these canals, consisting as they do of fibres. Besides which, no greater quantity of the resolved blood can be admitted into the animal spirit than the natural necessity, as measured by the use and end, demands.* But how all these operations are carried on, we can at present only guess, in the absence of positive information derived from the microscope; let us, however, remark that here all is done in a more distinct manner than in the larger or compound canals, according to a rule laid down in Transaction I [n. 161].

50. *Since the blood contains within it the primitive elements of every degree, from which, therefore, can originate every possible thing that can exist in the body; and since the seed, the purest essence of animal life accumulated in the minute tubules, requires supports, in order that it may be formed suitably and distinctly according to the several parts it has to play, therefore, of necessity, the blood must flow in and perform this work.* That the blood contains within it all those elements of which the entities of the elemental world are made up, see Transaction I [n. 59–61]. It is necessary that the blood be now invited hither; for nothing can be formed without its aid, since without it there would be lacking the instrumental cause, without which the principal cause could not expatiate beyond its own sphere. *Whence it follows that no seed can be prepared without the assistance of the blood or of its spirit, which is called animal spirit; hence that the first conjunction or formation is effected in the testes and their tubules, particularly in the neighborhood of the larger canals, that is, at the place where the lesser canals come together beside the corpus Highmori or the lateral node.* If the most pure animal essence in which the life resides were not at once fixed by means of animal spirits extracted from the blood, its nature is such that it would instantly volatilize, and be dissipated. Hence it follows of natural necessity that this essence must be fixed before it passes into canals of any size. Nor do I think it can be doubted that a larger quantity of blood is derived thither. Thus the purest substances are allotted the inmost place, and the less pure the next place; so that the latter not only enfix the purest substances, but so enfold them as to enable them to perform their use.

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[1] That is, Transactions V and VI. See notes to n. 10 and 20.

51. *These exquisitely fine forms of the seed commenced in the testicles, are at length perfected in the parastatæ; that is to say, are surrounded and bathed with the multitudinous spirit of the blood and are fixed in such a manner as to embolden them to venture further outwards, and to run forth through the vasa deferentia; for which reason a larger quantity of blood is derived from the spermatic or pampiniform vessels towards the parastatæ than towards the testicles themselves.* A number of pipes or conduits originating from the innumerable minute vessels of the testes, run to the epididymides to which an abundance of the nobler blood is thus supplied. These vessels have been clearly seen passing over into and penetrating the epididymides, and, therefore, no doubt can be entertained of their actual existence. *This spirit of the blood is elicited not only from the blood itself but also from the testicles. For the fibres that flow into the testes are compound, and carry the spirit called animal spirit; this spirit cannot get into the tubules themselves, the latter being woven of none but the simpler fibres; and, therefore, before they enter, they let this spirit drip out into the interstices between the tubules; and from there it can be derived only towards the corpus Highmori, or the axis, and so right on into the parastatæ, where it performs a service similar to that performed by the blood when* *resolved into similar spirit.* Morgagni shows [n. 33] that there is something conveyed from the testes to the epididymides immediately, and not by the highway of the tubules; and this something can be no other than that mystic essence which courses between[1] the tubules, or that first compound which is sent forth by the fibres. That this is the animal spirit will be shown in the treatise on the Fibre.[2]

52. *In the parastatæ, therefore, there is no new composition of the seed whose formation is commenced in the testes, but simply a condensation of that exquisitely fine envelope wherewith the true and vital substance of the seed is enswathed. This little tunic, which is shapen by the animal spirit especially, at length grows strong enough to allow it with safety to be put out and extruded through the vasa deferentia into the vesiculæ seminales.* Every minutest part of the seed may in a manner be compared to a little egg, the substance whereof would easily run away unless it were guarded by a shell. This shell, or rather tunicle, is prepared on the passage through the corpus Highmori, and particularly in the parastatæ. Thus there is no new composition accomplished in the latter, but only a provision for the preservation of this most noble essence. For, according to the order of nature, the first envelope that surrounds and encloses it must be a substance that closely approximates to the perfection of the essence enclosed, and, therefore, must be that spirit which is called the animal spirit; and then must come the purer elements of the elemental world which are contained in the blood and which thicken this fine shell and give it immunity against all perils. This then, the very first operation, is what is carried on in these organs which we first encounter; other organs then succeed them in regular order and make up the humor which is visible to the naked eye and which is superficially termed the seed. And it is to be remembered at the outset that in the mother's womb, Fallopian tubes and ovaries the compounded seed is again resolved in the same order as that in which it was compounded. Furthermore, that a considerable supply of animal spirits flows in from the parastatæ, may be inferred from the fact that they too are surrounded with the tunica albuginea, consequently with a fibrous tissue.

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[1] The Latin has *intra* (within), but the context seems to demand *inter* (between).

[2] See also the little work on the Animal Spirit (in POSTHUMOUS TRACTS).

53. *With regard to the tunica vaginalis, which is a production of the peritoneum covering the spermatic vessels, it appears to serve the use, not only of protecting the testis and enabling the arterial vessels and the nerves themselves to enter with safety under its shield, but also of receiving all that impure matter which is excreted by the arterial vessels, and which is not conducive to the first formation of the seed.* For at this threshold the arterial blood cannot be so pure but that it still carries with it a certain serosity and comparatively gross material. Moreover, in the very globules of the blood lie many things that are by no means suitable for this virgin and most pure seed; such, for instance, as urinous, alkaline, saline, and many others. Hence receptacles must be provided whereinto the heterogeneous or grosser parts may be sent away; and the nearest receptacle is the tunica vaginalis which loosely surrounds the tunica albuginea and which, moreover, is finely cellular, descending as it does from the cellular tissue of the peritoneum. Underneath this tunic pass the vessels of the testes and epididymides, which give to these organs many twigs and threads. This tunic, therefore, is provided for the purpose of absorbing the grosser material of the blood and of allowing none but the purer essences to make their way into the laboratory.

54. *But the outmost and muscular tunic, called the cremaster muscle, is continued from the ligament of Fallopius*[1] *and from the corpus pyramidale, that is, from the spermatic cord, and does not seem to either compress or relax the testis, but only to erect it, and by erection to so dispose it as to enable the blood from the spermatic vessels, and the spirit and purer essence coming through the nerves, to flow into the testis and its appendage. For unless the testis is erected the vessels and nerves are folded up, and also the middle septum or little diaphragm; hence an obstacle is raised up against the influx of the first materials of the seed. This is the reason why in the venereal act the testes and parastatæ are*

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[1] Poupart's ligament.

raised up and become quite rigid; while, on the other hand, in the intervals the connection is more flaccid or in a manner ceases. By this means there is not so great irritation outside the act, and still less during seasons of prolonged chastity. Anatomists are agreed that the cremaster raises the testis and parastata, but does not compress them. If it did the latter, it would exert only an empty force upon the tunic proper to the testis, since its force would be exerted upon the tunica vaginalis, which is the intermediate tunic. The testis obtains its sufficient power of action from the abundance of its own proper spirit; but when erected it is so disposed as to admit the transflux of the blood and the transflux of the spirit of the fibres, in the freest manner. Such erection proceeds from the same cause as the erection of the penis and the other genital organs, namely from the nerves as a result of the brain's engaging in the work of venery; for then all the spirit, as though exhilarated to the utmost with venery, opens up the minutest fibres, and thus erects the muscular fibres and particularly the cremaster; for these same nerves also flow into its motive fibres. By means of this animal dispensation the wisest care is taken to prevent the testes from continually allluring away a quantity of the purest blood and spirits, which would be to the injury of the whole system and animal.

55. *It cannot for a moment be denied that the testes enjoy a motion of their own, that is, a kind of alternate expansion and compression, but almost imperceptible; for there enters into and pervades its structure, not only a vast quantity of fibre, but also an uninterruptedness of artery. Nor likewise can the testes, any more than the rest of the viscera throughout the body, be denied an extraordinary motion during the whole of those periods when the exercise of venery is going on. Thus neither can they be denied a general motion, which is evidently synchronous with that of the peritoneum, that is, with the pulmonic motion.* Of the proper motion there is no doubt; for though the minutest vascular twigs do not perpetually flow in, yet the larger branches do, likewise also the nervous juice. But that the general motion, that is, the motion of the whole body of the testis, coincides with the motion of the peritoneum and hence with the pulmonic motion, is evident from the mere connection of the parts. For the production of the peritoneum is continued around the spermatic vessels all the way to the testis where it opens out and clothes the testis in what is called the tunica vaginalis. So likewise there is an aponeurosis from the internal oblique muscle of the abdomen, which presses round the external tunic. Thus when these muscles and the peritoneum are raised up or let down this appendage must needs be similarly moved; and since, as everyone knows, the first motion coincides with the respiration of the lungs, it necessarily follows that the general motion of the testicle is synchronous with the pulmonic motion.

CHAPTER III

THE SCROTUM.

56. WINSLOW. (*Expos. Anat.*) The scrotum is a bag, common to both the testes, formed by the continuation of the skin of the neighboring parts, and commonly very uneven by reason of the many rugæ on its outer surface. Interiorly, it is fleshy and forms for each testis a muscular capsule termed the dartos. The external or cutaneous portion of the scrotum, is of nearly the same structure as the skin, but somewhat finer, and likewise plentifully beset with numerous granular points, called sebaceous glands, and with tufts of hair. It is divided into two lateral parts by a superficial and uneven prominent line which appears like a kind of suture, and is therefore termed the raphe. This line is a continuation of that which, in the same manner, divides the cutaneous coverings of the penis, and it is continued all the way to the anus, passing through the perineum, that is, the space between the anus and the scrotum, which it likewise divides into two parts. It is only superficial and does not appear on the inside of the skin. The inner surface of this cutaneous bag is lined with a fine cellular membrane through which the glands and hair bulbs are distinctly visible when the membrane is examined from within. The rugosity of the scrotum is a sign of health (*Tr. du Bas Vent.*, n. 493–497).

57. The dartos, or fleshy portion of the scrotum, is a true cutaneous muscle, the fibres of which are, for the most part, closely connected with the skin, running through the cellular substance which lies between these two portions. It serves in the place of an adipose membrane, but is without any appearance of fat. This muscle is thin, and by the disposition of its fibres, it forms a bag with two cavities which constitute two smaller bags. The lateral parts of these two bags, which are turned from each other, are longer than those which are joined together. By the union or contact of these two dartoi, a septum is formed between the testes, called by anatomists the mediastinum of the scrotum. The raphe or suture already mentioned adheres to the edge of this mediastinum and thereby braces down the middle of the cutaneous portion, which thence appears to have two cavities. The other edge of the mediastinum is attached to the urethra. The two bags of the dartos are lined on the inner or concave side, by a cellular substance more considerable than that between the convex side and the skin; so that the muscular fibres, all the way to the septum, lie between two cellular beds. They run through the outer bed, as has been said, to be inserted in the skin, and by their contraction form the natural rugæ of the scrotum. These muscular fibres have likewise a close connection with the internal cellular membrane, especially at the upper part below the groin where the anterior and external lateral portions of the dartos terminate by a kind of tendinous or ligamentary expansion which is strongly united to the internal cellular membrane. I have often shown this as a particular fascia lata which gives insertion to the portions of the dartos just mentioned, and as a broad frenum which keeps the same portions together. The aponeurotic or ligamentary expansion of the dartos is attached to the ramus of the pubic bone between the triceps and the origin of the corpus cavernosum of the same side, all the way to the lower part of the symphysis pubis. The internal portion of these muscular bags, or that which forms the septum, is attached to the urethra by means of a communication between the same ligamentary expansion and another, of which we shall speak in its proper place. (*Tr. du Bas Vent.*, n 498–503.)

58. HEISTER. (*Compend. Anat.*) The scrotum or little bag or pouch, furnished with hairs, is divided by a suture into a right and left portion. The muscular membrane, termed the dartos, serves to corrugate it. The septum is formed by the doubling of the dartos whereby the scrotum is divided into two compartments. Its vessels come from the pudendal and hypogastric vessels; its nerves from the sacrum. (n. 224.)

59. SCHURIG. (*Spermatologia.*) In cases of hernia, and indeed in hydrocele and sarcocele,[1] as well as in intestinal hernia, the scrotum is greatly extended beyond the normal size and takes the shape of a large and longish gourd or cupping glass. In one case, it was a foot and a half long and three feet and a half in circumference, and weighed thirty-four pounds. In another, it reached to the knees, and not a trace of the penis could be seen. In one instance, it was far bigger than the human head. There are also cases recorded in which the scrotum was distended by flatus to the size of a young child's head. In Egypt, the part is frequently subject to fleshy excrescences of a huge size; so much so that a piece removed from one subject weighed twenty-five pounds.—Cases where the scrotum and testicle are lacking though the penis is entire; these are congenital. Other cases where the scrotum is absent while the testicles and penis are both entire; these are the result of gangrene, or of intense cold, whereby the scrotum has been killed by sphacelus[2].—This is called sphacelus of the scrotum, of which other cases are given.—The scrotum has also been observed to be covered over with a stony crust.—Calculi of amazing size found in the scrotum.—A wart hanging from the scrotum and in shape like a mushroom. (II, § 32–37.)[3]

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[1] Hydrocele, a collection of serous matter in the texture of the scrotum. Sarcocele, a hard swelling of the testicle, which is extremely painful and dangerous.

[2] Sphacelus, a term signifying mortification, or the disorganised parts resulting from mortification

[3] Our author's quotations from Schurig, frequently, as in the present case, consist of little if anything more than the index words printed in the margin of Schurig's paragraphs.

INDUCTION.

60. *The genital members occupy the fourth and lowest region of the body, standing outside the third or abdominal region from which they are separated and with the parts of which they are at the same time united,—a sign that all are dedicated to peculiar uses. The genitals, however, are like extremities and ends to which the members that stand above them aim. For the latter not only excrete into them all that is superfluous and unfitting, but they aim thither for the further reason that where the end is there also may be the beginning of a new animal being. This is effected when the male is conjoined with the female and they coalesce into one body, as it were, formed from two.* For it is a law of nature which rules everywhere, that where an end is, there is a beginning,—on the model of the perpetual gyre or circle shown by geometry; for from this arrangement arises a kind of perpetuity and continuity. *In order then, that all the members or organs devoted to generation may be mutually connected and may absolutely conspire to one common end, this cavity is prepared, and is covered over with tunics and discriminated by a septum, whereby all these organs are marvellously connected, and mutually inter-communicant. This cavity is the scrotum, divided into two compartments by the septum and mediastinum just as the thorax or the two lungs are divided. This septum communicates with the spermatic vessels and also with the didymi or testicles and their appendages, by the vasa deferentia; thus with the vesiculæ seminales, and likewise with the urethra, and so with the prostates. Without the scrotum and the gyre made by its tunics no such connection would ever be effected.* These particulars are of a purely anatomical nature, and are clear enough from mere anatomical experience. The connection itself, therefore, being beyond all doubt, I say no more about it. But in order to show the reason of all the connections, we need an explanation of the other genital members to be treated of in the sequel. Here we shall only remark, that near this septum the spermatic vessels enter the testicles, and from this septum the urethra is continued. Hence, since this septum communicates with the first and last parts immediately, it also communicates with all the others mediately.

61. *There are two orifices by which the superfluity of the whole body is excreted,—the orifice of the urethra, through which the urine is discharged, and that of the anus, for the unloading of the feces. These orifices serve as the extremes of the whole body; but they communicate with each other in the most evident manner. For externally, there is a kind of white tendinous band which, commencing from the orifice of the urethra, extends thence along the tunic on the under side of the penis, and also through the scrotum and perineum, all the way to the other orifice, viz., the anus, where it ends. Furthermore, this band is attached to the extreme part of the septum that divides the scrotum into two compartments and runs all the way to the insertion of the spermatic vessels, and at the same time to the beginning of the urethra. Thus it makes a sort of circle, and gathers itself up into a kind of centre, wherefrom it again goes to the circumferences.* That this white tendinous band reaches from the under side of the glans penis, or from the orifice of the urethra, through the scrotum to the anus is obvious to everyone, and, moreover is a fact mentioned by the anatomists. That this band, the course of which is only superficial, is somewhat adherent to the septum, is shown by Winslow. By this septum therefore, it tends to the spermatic vessels and also to the beginning of the urethra; for to the latter, the septum is attached, see Winslow [n. 57]. Thus it is apparent that a kind of gyre is formed, beginning as it were from the centres and ending on both sides in the circumferences and their two foci. *We again find a similar arrangement when, by these two orifices, the urethra and the rectum, we penetrate towards the interiors; for there likewise, we come to a kind of centre, namely, to the beginning of the urethra, or the neck of the bladder, and the prostate glands,—the rectum being adherent by ligaments to the neck of the bladder.* Thus we meet a similar gyre. This is the reason why these members have so close an intercourse with each other, and why the penis is erected when the bladder becomes distended, particularly in the night; also why the urine is held while the feces are being discharged; and why both these evacuations are suspended when the seed is emitted. The reader will best inform himself respecting this connection by dissection and plates; we shall have more to say about it in the sequel. *This is the reason why the several genital members are excited to the exercise of venery both immediately and mediately according to the connection of the parts,—naturally in coition, and artificially or lasciviously whenever this band or general frenum under the orifice of the urethra, or in the perineum itself is softly handled and stroked.* For on both hands the effect of the titillation redounds from the circumferences to the centres, that is to say, to the spermatic vessels, didymi, vasa deferentia, vesiculæ seminales, prostates and urethra; which would not be the case if there were no scrotum and scrotal septum to wonderfully conjoin the several parts, and, by a double gyre, external and internal, to carry up to those centres the whole caress and tremble of the touch. By virtue of this gyre and connection, there is not a part but at once feels a like titillation calling it into play.

62. *Moreover, the scrotum serves not only for connecting the several members devoted to generation, but also for guarding and preserving them against all injury and hurt, from whatever cause, extrinsic or intrinsic. Particularly does it thus minister to the testicles, which are the chieftains of the band and do the principal work. For the scrotum serves as a cushion to the testicles, irrigates them moreover with pleasant humor, and keeps them uniformly safe in their natural state and in their proper places.* That is to say, it protects them against heat, cold, knocks, rubbing against the adjacent parts and tunics, etc. And, moreover, to secure their indemnity, they require to be always circumfused with warmth and moisture, like the rest of the abdominal and thoracic viscera, and like the brains themselves, of which we have already treated above[1].

63. *Moreover, the muscle of the scrotum, that is, the dartos, by a kind of external and general aid consequent upon the contraction of its fibres, raises the testicles into their natural situation, that is to say, into such situation that the blood of the spermatic vessels, and also the spirit of the fibres, may flow in as they ought, and that*

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[1] The reference is probably to the ANIMAL KINGDOM.

in like manner they may at the same instant open the passage for the spermatic vessels and the fibres. As was observed above [n. 54], with regard to the cremaster. For when the cremaster is in action it raises the testicles and gives to the blood and spirit the opportunity of flowing into the didymi through the arteries and fibres. But since this force is only particular, and is somewhat feeble, a general force is required which shall coöperate. For when the cremaster muscle contracts and wrinkles the scrotum, and when at the same time the muscle of the septum does the like, then certainly the testicles must be raised up to the natural level by an external and general force. And in order that the particular muscle, that is, the cremaster, and this general muscle may thoroughly conspire together, the latter sends out on both sides and through the septum itself, a kind of ligamentary, tendinous and aponeurotic fascia, to the end that it may entirely concur with the action of the former. Thus the forces of the scrotal muscle or dartos are concentrated around the insertion of the cremaster. The dartos, moreover, also concurs with all the other muscles that excite these genital members,—but in a peculiar way, as is manifest from the nerve that is sent to the scrotum from the sacrum. This nerve forms a remarkable contact and conjunction with the great ischiatic nerve, and also with the nerve that goes to the testicles; so that it is a kind of mediating nerve which unites all the nerves that excite the muscles to the act of venery, and which at the same time unites to them the cremaster muscle.[1] According to the application and conjunction of the nerves, such is that of the muscles; for the latter are excited to action solely by the nerves Confer Vieussens' *Neurographia*, tab. xxix. *This is the cause of the wrinkling or rugosity of the scrotum, to wit, that when need requires, it may rightly dispose the testes, and at the same time all the other genital appendages, to their use; and also that in the intervals when there is no such need, it may give way or relax;*

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[1] The nerve referred to seems to be the third sacral, see Plate X. This nerve after contributing to the fourth sacral to form the pudic nerve, joins the sciatic, from which it afterwards emerges to form, with fibres of the second sacral, the small sciatic which is distributed partly to the scrotum. See n. 35 above.

and that the seminal essence may not run perpetually into the testicles, depriving the blood and the other viscera of their vital spirit. For the first or spirituous essence of the seed does not flow in, save when these members, and particularly the testes, maintain their natural position. Hence, when the scrotal muscle is relaxed, they fall out of this situation, and these members are thus deprived, for the most part, of the afflux [of the seminal essence]. Therefore, when the dartos contracts and wrinkles the scrotum, it is a sign of an abundance of spirits, as well as of health and proclivity to venery, in short of sustained vigor.

64. *For the rest,—as regards the use performed by the two cellular tissues of the scrotum, that is to say, as regards the humor that they carry, and the destination whither they send it,—this will come to be explained later, when we take up the subject of the urethra.* For there are two cellular tissues one on each side of the scrotal muscle; as is likewise the case in the intestines and other parts. How these tissues receive the humor expressed from the muscles, not only from their own muscle which lies between them, but also from many other muscles, and how they drive it into circulation, and lastly discharge it for the service of the seed, will come to be explained below.

CHAPTER IV

THE VASA DEFERENTIA.

65. WINSLOW. (*Expos. Anat.*) The vasa deferentia[1] are two white, firm and somewhat flattened canals, one on the right side, the other on the left. From the epididymides, of which they are continuations, they run up in the cellular sheaths of the spermatic vessels, and alongside the vessels, as high as the opening through the abdominal muscles,—the blood-vessels being in front, and the vas deferens behind. The bundle thus formed by the blood-vessels and vas deferens and their common covering, is termed the spermatic cord. The covering is closer on the outside than on the inside. The internal tissue, which is more cellular than the external, connects all the vessels together, and the external forms a covering to invest them. Having reached the membranous lamina of the peritoneum where that lamina covers the orifice of the sheath, the vas deferens separates from the spermatic vessels and runs backward in the form of an arch in the cellular tissue of the peritoneum as far as the adjacent side of the bladder. It glides behind the body of the bladder,—to which it closely adheres, as also to the lamina of the per toneum which covers it,—and then continues its arched course as far as the neck of the bladder, where both vasa deferentia meet and their arches terminate. In this course, the vas deferens crosses behind the neighboring umbilical artery; it also crosses the extremity of the ureter of the same side, in its passage between that extremity and the bladder. Having got behind the bladder, it meets the vas deferens of the other side, between the insertions of the ureters, and the two vasa deferentia then run down together to the neck of the bladder. This canal, which at its origin from the epididymis is pretty thick and plaited, soon becomes smaller and closer in texture, and so continues till it gets behind the bladder, where it again begins to be thick and irregularly plaited. It arises from the posterior extremity of the epididymis, and from thence runs forward in an oblique course on the posterior half of the epididymis, where it bends a little back to mount behind the spermatic vessels. The closely textured portion of this canal is firm and as it were cartilaginous, especially round the surface of its cavity, which is quite narrow. The cavity of the vas deferens is cylindrical, though the whole tube is flat and its external circumference oval, as may be seen by cutting it transversely. The cavity grows gradually larger as it passes behind the bladder. (*Tr. du Bas Vent.*, n. 504–512.)

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[1] See Plates I, II and III.

66. Heister. (*Compend. Anat.*) The vas deferens or ejaculatory vessel is a strong, whitish canal, resembling a nerve, and of the thickness of a middle-sized straw. One such vessel runs from each epididymis to the vesiculæ seminales and the urethra. From the epididymis it ascends through a process of the peritoneum to the abdomen, and is reflected thence to the neck of the bladder. It terminates in the front portion of the vesiculæ seminales, running in part straight into the urethra, and in part obliquely into the vesicula seminalis; thus it can deposit its liquid in either, as need requires. In substance, it is robust and tough. At its beginning and in its progress, its cavity is so fine as scarcely to admit a bristle; near the bladder, it is much larger; at the end of the tube, it again narrows, and affords no spontaneous passage into the urethra, except only during the venereal paroxysm. (n. 226.)

INDUCTION.

67. *The vasa deferentia are the emissary vessels of the testicles, considered as glands. By means of the parastatæ from which these vessels immediately proceed, the axis of the testicles, that is, the corpus Highmori, is continued all the way to the vas deferens. The latter, therefore, is this same axis continued all the way to the urethra and ending only in the glans penis. The vesiculæ seminales do indeed take up this continued axis on the way, but they are only diverticula, and notwithstanding them, the canal is also continued on into the cavity of the urethra.* The vasa deferentia come off from the epididymides, but still we may conclude from the connection here, that, by means of the epididymides, they really spring from the axis of the testicle or the corpus Highmori; for this axis concentrates the forces of the whole testis on the whole epididymis; and thus, by means of the epididymis and all its tissue and the whole of its fibres, it determines those forces to the vas deferens. Examination of the epididymis shows that its entire cavity and porosity looks to this orifice alone; which, therefore, is a continuation of the axis, and consequently of the testicle, following the directing line of all its parts. And that this axis, thus continued, is determined onwards to the urethra, is evident from the immediate communication of the vas deferens with the urethra, and its mediate communication with the vesiculæ seminales. That the latter are stations on the road, is plain from their situation and office, in that they are repositories for the superfluous seed. *Hence, all the fibre of the whole testicle and of its canals, which is determined by the septa into the tunica albuginea and from this into the corpus Highmori, is continued to the vas deferens as far as the urethra.* Not unlike as is the case with the fibres termed corporeal fibres, which proceed from the cutaneous glands, and thus from a new origin; in which respect the vas deferens deserves to be called

the great or grand corporeal fibre.[1] *Hence, it follows, that the whole force and action of the testicle, is determined at last to this vas deferens serving as an axis; and therefore, that the vas deferens draws its proper determination from the testicle and all parts belonging thereto. For no fibre enters the vas deferens immediately, its fibre being the continued fibre of the testicle, and particularly of the tunica albuginea. Hence, from no other source can it receive its power of action.*

68. *Now, since the testicles enjoy a peculiar motion of their own, and likewise a general motion, and moreover, in the act of venery, an extraordinary motion* [*n.* 55], *so also do the vasa deferentia. For the proper motion of the testicle passes into the fibres and into the coat of the organ; and so likewise does the whole of the extraordinary motion, and the general motion also, which, synchronous with the motion of the peritoneum and with the pulmonic motion, is continued by means of the peritoneum and its production, and finally by means of its bladder.* As to the proper motion, this is plain from the connection just pointed out, which is tightened every time the testicles are raised up by means of the cremaster. When this takes place, the vasa deferentia also are brought into the same situation and faculty of action; for they proceed under the same capsule or sheath as the spermatic vessels, and are excited by the same common muscle. That they are subject to the same general motion is plain enough, from the fact that they likewise are included in the production of the peritoneum, and continue their course right on to the aponeurotic ring of the internal oblique muscle. Thus whatever general action results to the spermatic vessels, and therefrom to the testicles through their tunica vaginalis and muscular coat, the same also comes to the vasa deferentia, which are then held in the same stream of motion with their most individual fibres,—and this all the way from their first origin, that is, from the brains. So the whole effect follows with inevitable certainty. *From these considerations it now follows that there is some notable expansion and constriction of the vasa deferentia, brought*

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[1] The Latin here is *fibra corporis* (fibre of the body); but the context seems to indicate that this is a slip or misreading for *fibra corporea*, (corporeal fibre). As to the nature of the corporeal fibre, see the FIBRE n. 168 *seq.*, and also 2 A. K. 504 *seq.*

about by means of the tunic,—a motion which must be the more considerable in proportion as the tunic is denser or consists of more numerous fibres; for there is not a fibre in the vas deferens but corresponds to some fibre in the testicle. The tunic of the vas deferens is somewhat thick and robust, of an oval form externally, but almost spherical within; showing that it consists of the multiple and almost continued, but compacted fibres of the tunica albuginea. Hence it follows that every fibre of the testicle has respect to some fibre in the vas deferens, and hence, as a consequence, that there is a notable expansion and constriction, arising, that is to say, from the individual parts or fibres, which, during infancy, are softer and consequently better fitted for action than in adult life, when they are usually condensed into a substance not unlike cartilage.

69. *In order that these deferent canals may be adapted to every general motion of the abdominal muscles, peritoneum and bladder, and may ever be safe from harm whatever perils of motion surround them, they pursue their course by oval windings. Otherwise, were they stretched in too straight a line, their general motion, and particularly their extraordinary motion, would perturb the proper and interior motions of the vessels.* We may all know by simple reflection on our own persons, what the action of the abdomen is during the various bodily efforts, as in struggling, stretching ourselves in the morning, sneezing, discharging the bowels, and particularly in the venereal paroxysm; and moreover, what the action of the bladder is when forcing out the urine; in a word, what these actions are in our several acts both natural and extraordinary. If, therefore, the vasa deferentia did not run in windings and curves, but were stretched out in straighter lines, then, in the midst of all these violent motions, they would inevitably undergo extension and contraction,—when yet their expansion[1] and constriction ought to depend on the action of the testicles; hence, the two motions would be confounded. Wherefore they are so adapted to the peritoneum, both in the capsule and beyond it, that they can yield in whatever direction the force is applied, and be freely left to their own principles of motion.

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[1] *Expansio*, perhaps a slip or misreading for *extensio* (extension).

70. *Now as the tortuous tubules of the testicles carry only the purest essence of animal life; and as, in the grouped canals, and finally in the epididymides, copious supplies of animal spirits are thrown in, which, like surfaces over kernels, envelop this substance in a shell of the softest kind, so now it follows that the canals which carry this substance, now compounded or fashioned, are made up of the fibres of the testes, and consequently are purely nervous; and that this nerve is compounded in like manner as the substance that flows through it, in order that the containant may exactly correspond with its content.* This follows as a consequence from the very composition of the seed. In its first composition it consists of nothing but the purest substance or essence of life, which the spirit of the blood, or the animal spirit, softly surrounds after the manner of a surface. Thus it can have no other tunic than one that in all respects is correspondent with itself; for every tunic is wholly accommodated to its contained fluid, as was observed in Transaction I [n. 133 *seq.*], in speaking of the arteries. From the containant, therefore, is known the nature of the content. And that the content, in the present case, is such as we have described it, is evident from an enucleation or unfolding of the seed itself.

71. *A work similar to that commenced in the epididymides, is continued throughout the whole extent of the vasa deferentia; in order, namely, that the convolutions of the purest seminal substance may be girt about with a fitting surface, and that this surface may continually increase in strength and thickness through the whole of the deferent tube or canal, the very length of which and the perpetual convolution of its parts, is conducive to this work.* The first composition, as was said above, is carried on in the epididymides; yet it is not completed there, but only slightly commenced. A quantity of spirit is poured on by them, which is elicited in abundance from the blood and the compound fibres. This juice, or this spirit, is copiously poured into the vasa deferentia by the epididymides. Thus, as this genital substance runs through its canal, it is continually circumfused by the juice and spirit that environ and beset it; especially since it has to pass through so long a tract. For if the motion of each seminal globule is to be inferred from the form of fluxion of its simple substances, it will follow from the very connection of things, that the form of fluxion of each globule is of a most perfect kind, namely, is perpetuo-spiral or vortical; respecting which see the Doctrine of Forms.[1] Hence it follows, that each of these minute seminal or genital globules will continually cover itself over, by a perpetual or vortical whirling, with a new and denser surface; and this all the way from the appendages of the testes to the vesiculæ seminales or the urethra. *Thus the deferrent canals complete the work that the epididymides begin.*

72. *In order then that all things may be carried on rightly and according to the universal order of nature, the beginning of operations and the end of the same must concur; so also the influx of the blood and spirits into the testicles, and their efflux from the testicles. For this end the spermatic vessels are enclosed in one and the same capsule with the vasa deferentia; and the two flow in and flow out together and in the same place. Thus while the venereal act continues, as much of them flows in as flows out,—and this by the same alternation of action.* Nature everywhere keeps and cultivates her universal laws as sacred, for they are most perfect, and breathe continuity or perpetuity. When, therefore, propagation and the necessity of society are the business in hand, the principles and ends are connected in no light fashion, but the connection extends to a considerable tract. For the spermatic vessels that enter into the testis, and the vasa deferentia that go out from the testis, are contained within one and the same capsule all the way to the aponeurotic ring of the abdominal muscles; thus the effect cannot possibly fail the cause.

73. *When, in the venereal heat, all the fibres, now put on the stretch, are set mobile and tremulous, it is further necessary that the continued fibres, namely, those of the vasa deferentia, be in the same state, and indeed, in a still greater and grosser tremble according to the degree of composition, so as to act upon the enclosed seed* (genitura), *not only by reciprocal alternations of expansion and constriction, but also by a certain tremiscence. And because the seed, of its own nature, is most prone to every motion,—and especially to that most perfect of motions, gyration,—therefore, by the similar and accessory motion of the tunic, it is carried*

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[1] See the Fibre n. 255 *seq.*, and particularly on the perpetuo-spiral or vortical form, n. 265.

along into this same motion in the most vehement way. These purest substances of animal life are adorned with gifts of supreme perfection; that is to say, they possess a primordial and supreme force or power of elasticity, as well as a like power of expansibility, compressibility, modificability, gyrability, and fluidity. Hence, when external impulsive force is added to the internal, this force is so exalted that at the least impulse it strives as it were spontaneously towards its outlets, even though the path lie through the longest canals. The nature of the force that lies in the spirit from one extremity to the other, that is, from the cortical gland of the brain to the motive fibre of the sole of the foot, is clearly evident from its effects. This genital substance consists of similar spirits, but more compounded and thereby formed into a substance of the next lower degree; therefore it cannot fail to have the next quality and perfection, as will be seen in the Doctrine of Forms.[1]

74. *From the above considerations, it is now evident why so narrow a canal suffices for this substance,—a canal, which nevertheless is capable of transmitting an abundance of genital humor.* We must not consider the capacity of the tube, unless at the same time, we consider the purity, swiftness and elasticity of the fluid which runs through it,—all of which are mutual correspondents. A fluid that is highly pure, elastic and rapid in motion, will run through the smallest tube in a quantity equal to that of a gross, corporeal and comparatively slow humor running through a larger tube, even one that is visible to the eye. That this is true as a matter of geometry and physics, will be acknowledged by everyone who is acquainted with the rudiments of these sciences. *This is the reason why the vasa deferentia at the beginning and end are so narrow as scarcely to admit a bristle, while in the intervening course their calibre is greater; from which fact we may judge, that outside the act of venery, the orifice into the urethra is closed, and that into the vesiculæ seminales open; while, on the other hand, during coition, the orifice into the urethra is open.* This conclusion follows not only from the effect, but also from the organic connection of the parts; as becomes evident when we more closely examine the insertion

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[1] *Cf.* The FIBRE, n. 258–259, on The Animal Spirit, in POST- 264–265. See also the little work HUMOUS TRACTS.

of this tube into the urethra. At this threshold, the urethra also is kept closed. Furthermore, the erection of the penis, the tremulous excitation of the deferent canal and the action of the testicle on this external part, all are efficient causes of the opening of this tube at its two extremities.

CHAPTER V

THE VESICULÆ SEMINALES.

75. HEISTER. (*Compend. Anat.*) The vesiculæ seminales[1] are two membranous cellular receptacles, united to the posterior part of the neck of the bladder, intended for the reception of the seed from the vasa deferentia, for its further perfection and for its expulsion through the urethra. Their length is three finger-breadths, and their width one. Their substance consists of a strong vascular and as it were muscular membrane, forming various intercommunicating cells, and enveloped in a robust layer of peritoneum. The cells, however, may be resolved into a single blind cavity, as it were a small cœcal intestine. Their excretory ducts are two in number, one from each vesicula; generally each duct has its own orifice into the urethra. Their blood vessels are very numerous and come from the vessels which supply the bladder and rectum. Their nerves come from the pelvic plexuses. Their inner surface is reticulate and wrinkled, like that of the gall bladder; some authors allege having here seen glands. (n. 227.)

76. WINSLOW. (*Expos. Anat.*) The vesiculæ seminales are two whitish, gibbous, soft bodies, about three or four finger-breadths long, one broad, and about the third of one in thickness. They are situated obliquely between the rectum and the lower part of the bladder, in such a manner that their superior extremities are at a distance from each other, while their lower extremities are united together between the extremities of the deferent canals, of which they imitate both the obliquity and the incurvation. They are irregularly rounded on the upper part, and their breadth decreases gradually from thence. By the union of their lower extremities, they form a kind of fork, the branches of which are broad and bent like ram's horns. These extremities are very narrow, and form by their union a small beak, which glides under the bladder toward its orifice, and continues its course in the groove of the prostates, and in the substance of the contiguous portion of the urethra, where their extremities at last pierce the substance of the caruncula. The inner substance of the vesiculæ is plaited, and in a manner distinguished into several vesicular capsules by tortuous folds. Their external surface is invested with a fine membrane, which serves as a bridle to the folds; this membrane is a true continuation of the cellular tissue of the peritoneum. If the folds are laid out, and the tortuosities untwisted, a body of some length is found to be the result. Their inner surface is villous and glandular, and continually furnishes a particular juice which digests and perfects the seminal matter. (*Tr. du Bas Ventre*, n. 545–548.)

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[1] See Plate III.

77. The passage of the vasa deferentia into the vesiculæ is very remarkable. I have already observed that these canals are curved backwards behind the bladder, and that their contracted extremities unite at that place. These extremities unite in the form of an angle, and lie between the contiguous extremities of the vesiculæ. The union is so close that the adherent portions seem to form only one middle septum between the two tubes, each of which is formed partly by the extremity of one vas deferens and partly by the extremity of the neighboring vesicula. The lateral union of the extremity of each deferent canal with the corresponding vesicula seminalis forms likewise a small particular septum which terminates in a crescent, like a small semilunar valve,—the extremity of the deferent canal being much narrower than that of the vesicula. This arrangement allows the fluid contained in each deferent canal to enter the contiguous vesicula, but prevents its exit from the vesicula into the deferent canal. If we blow into one of the vesiculæ seminales after compressing the urethra, the air inflates the contiguous vesicula and the urinary bladder, without passing into the vesicula or canal of the other side, unless we blow with violence. Finally, the two small tubes, each formed by the extremity of the deferent canal and vesicula, glide between the base of the prostates and the urethral canal; and, perforating the sides of the latter

obliquely, they terminate in the caruncula. (*Tr. du Bas Ventre,* n. 549–552.)

78. Boerhaave. (*Instit. Medic.*) The vesiculæ seminales, connected by membranes to the posterior part of the neck of the bladder, are small blind intestines [folded together into gyres, crypts and recesses]. The ejaculatory vessel enters these little intestines in almos a straight line, near their most capacious fundus; and from this point each vesicula is furnished with an emissary canal which joins the former canal at an acute angle. These two emissaries, uniting in the urethra at an obtuse angle, terminate in a single emissary duct which opens into the urethra. Thus the seminal humor is expelled hither by three distinct mouths. Meantime, both the vesiculæ are bound together by a muscular membrane. (n. 648.)

79. Schurig. (*Spermatologia.*) Nature endows the vesiculæ with a great many bendings, and distributes them into a kind of venereal woof consisting of eight or nine cells. (n. 35.)

INDUCTION.

80. *In the course of nature, none but the superfluous part of the first animal essence and its spirits is sent away into the seed; that part, namely, which is over and above after the proper quantity has been spent upon the blood, fibres, humors, glands, and members throughout the whole body,—in a word upon the universal economy. Those essences which are proper to each living creature are perpetually conceived and generated by their fountain-heads in the most perfect little laboratories, that is, in the cortical glands of the brain, and are put forth to meet all the uses of life. The organs which receive this most noble superfluity are the testicles; those which store it up are the vesiculæ seminales; and those which excrete it are the several parts of the urethra; wherefore all these organs, called the genitals, stand out beyond the trunk of the body, and there, in due season receive what remains over and above the outlay of the system. These organs are formed, and they increase and decrease, in accordance with the whole of their use. Therefore, in the first age of life when no more is generated than is necessary for the formation, vegetation and nutrition of the growing body, for distribution to the whole economy, and for the animal functions, these organs are not perfected and opened for this use. But as soon as ever the upper parts of the organic body have attained a certain stated dimension, they then, for the first time, deposit this superfluity,—as witnessed in the middle period of life,* [*namely*], *in adolescence, manhood, and adult age. Finally, in old age, when the surplus ceases and no more is produced than is fairly wanted to sustain the body, these organs are again closed, and diminish and shrink up; and, in fact, when the quantity excluded by its fountain-heads is insufficient for the body, as in cases of decrepitude, the very size of the body is lessened. Thus all things in the system in general, specifically and particularly, are exactly conformed and proportioned to the ratio of the supply and abundance of this the genuine animal essence, the first and the veriest, which rules everywhere in its*

little world. This equilibrium or equation might rightly be termed pre-established animal harmony. But of these subjects, we shall speak at greater length in our psychological transactions. *This superfluous part of the most noble animal substance, carried down into the testicles and there unloaded, is sent away through the vasa deferentia into the vesiculæ seminales and from the vesiculæ is finally drawn out through the urethral canal, into which last emissary channel, moreover, the grossest, vilest and last dregs of the blood are evacuated; for it is a constant law of nature that firsts and lasts should meet together, to the end that all intermediates may fitly conspire to both the ends; for, by this means, the likeness of a perpetual gyre is represented in all the single parts.* Respecting this constant law of nature, see what we have said above in various places.[1]

81. *But although this most noble essence of life thus appears as if it too were something excrementitious, from which the animal world must be purged as from a burden not conducive to its welfare; yet, since it is an essence within which is life and the first principles of the animal kingdom and the very nature thereof in her primes, therefore, this wise provision is made for sending it away, not on the score of superfluity, but for the use of procreating offspring. For this reason all is so provided that the seed does not run out spontaneously or without a cause, but is moved forward to its outlet by an antecedent will, an intermediary incitement, and a reception of objects and subjects offered to it and set before it, which complete the course of the means to the end; and thus, that, in man, it shall be dispensed rationally at the same time that it is dispensed naturally. Moreover, care is taken and command given, by a kind of rational instinct, that no more than the redundant portion of this most noble substance shall be thrown out,—and this lest any part of the individual life necessary to every one should be lost. This is the reason why this superfluous substance does not flow into the testicles all at once and at stated seasons only, but flows in successively and slowly in due proportion to its own generation and to the constitution of the body. And in order that this most noble extract may be drafted away successively and in similar proportion through the vasa deferentia into the vesiculæ seminales, and may there be collected as in a reposi-*

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[1] See n. 72.

tory, and be increased in quantity and perfected in quality until its supply is so copious and its quality such that it ought to be sent away for this use or end; in order also that it may stay there, and not burst forth or break open the doors until the final inciting forces are at hand,—for these reasons, it is superabundantly provided that it be cast out primarily for the use of procreation, and secondarily for that of evacuation;—reason and the mind being its dispensers.

82. *This superfluity of animal life, or of that essence wherein life so lies that it deserves to be itself called life, is sent away especially into the testicles, and is there so prepared as to be the inmost, supreme, most perfect and principal substance of the seed, and that which alone is genital and prolific. This is collected in the vesiculæ seminales, and there grows up and is perfected until it has attained to such quantity and quality that it can go forth to the use foreordained by nature. The seed may not improperly be compared with the seed of the subjects of the vegetable kingdom. Thus the seeds of trees and plants are inmostly enveloped in a kind of fruity sheath, and as soon as produced, they at once surround themselves with a covering and integument whereby they may be immune from every accidental injury, and may rightly perform the offices of rebirth. Then again they cover themselves round with a kind of flesh in considerable quantity; and this again they envelope in a coat or coats; as we see in various fruits, such as grapes, berries and the like. Reasoning then from analogy to the present case, and supported also by the nature of the seed as made known by chemical experiments, and as intimately disclosed by the microscope, we may infer that the seed is no simple substance, but is doubly and trebly compounded; and that each integral part of it is a kind of fruit, in the inmost parts of which, are laid up the genuine sperms; which sperms are further surrounded by a common tunic, and these again, as new compositions or combined forms, have stretched around them a tegument or sheath of the most general kind. The parts of the seed thus grow through three dimensions, before they are perfected and as it were ripened. The first dimension is perfected in the epididymides and vasa deferentia; the second and third, which are superinduced over the first, in the vesiculæ seminales. Thus the several parts of the seed are like little eggs surrounded* *with membranous envelopes and an exquisitely fine shell, and in whose inmost parts are laid up, like the seed in fruits, the true rudiments and stamina that are to supply the offspring with life and new generation. For this reason, the female organs, which are devoted to reception, conception and formation, are so formed as to again open up this humor in the same order as that in which it was fashioned in the male organs. I have felt called upon to briefly explain these preliminaries in order that the reader may comprehend the entire process of generation in one general view, and so may proceed to an examination of the several parts. And in what follows, I pray to be pardoned for making use of the terms in common use, in calling the first parts simple globules, the other or second parts, globules again compounded, and the third, true compound globules,—although it is plain enough that these first essences of the seed ought not to be called either parts or globules; yet since they must be expressed by intelligible words, such terms must be used as are analogically suitable.*

83. *With regard to the vesiculæ seminales themselves:* [1] *They are organs that collect and store up the first essence of the seed, or its simple globules in which lies the true seminal and generative power or life; in which respect they may be called Repositories and Reservoirs.* [2] *The vesiculæ seminales are also organs that digest the truly prolific, vital and seminal globules collected within them, rolling them about and well mingling them with grosser essences, to the end that they may be duly compounded into a form suitable for the use, and may be perfected and brought to maturity; in which respect the vesiculæ may be denominated Laboratories.* [3] *Lastly, the vesiculæ seminales are organs that excite the other genital organs to action; nay, that erect the urethra itself and its parts, the corpora cavernosa and the penis, and thus cast out the store which they have laid up and duly elaborated; in which respect they may be called Dispensers and Erectors. For they are placed midway between the urethra and the testicles and look toward both. Hence, when we seek for the proximate cause of the operations which occur in the process of generation, we find it in the vesiculæ seminales. Therefore we consider the vesiculæ as being the seat and native land, the isle* *and Paphos of Venus,*[1] *where her son Cupid is born and from which he aims his darts which are said to wound two breasts. For from the state and changes of these vesiculæ, comes the whole state of the effect, and the whole exercise of venery; and therefore they must be examined, not slightly, but thoroughly. Let us then weigh more searchingly, and one by one, the operations of the three functions just enumerated.*

84. [FIRST.] *That the vesiculæ seminales receive, collect, and store up the first essence of the seed, or its simple forms, or if you prefer, its globules, is manifest from the insertion of the vasa deferentia, which is such that, little by little and successively, they derive through the narrowest orifices all the prime seminal material from the testicles; after deriving, receive it; after receiving, collect it; and after collecting, preserve it for a considerable time. All this is clear from a mere anatomical examination of the connection of the parts.* Nothing can be plainer than that the testicles determine the whole of the substance extracted in their labyrinthine structure, into the vesiculæ seminales alone; and also that the latter receive it when thus determined, and long retain and preserve it when received. For, as indicated above [n. 80–81], the testicles derive none but the superfluous portion of the prime essence; and this is done successively, that is to say, from the successive increment, the mass grows and is heaped up.

85. *Thus a quantity equal to generation is heaped up; and thus the vesiculæ are not only Repositories, but also Reservoirs; for they are divided into distinct little cells, and, like the intestines, they are capable of being unfolded; moreover, they are rugose or wrinkled, so that they have room for enlargement; and therefore, they are well adapted for the storing away of a lesser or greater quantity.* Each vas deferens flows into the middle of the corresponding vesicula, and this middle is furnished with little compartments and cells which can be unfolded, as is evident not only from its rugosity and its consequent capacity for unfolding, but also from the effect itself; for the seed may be kept in the vesiculæ seminales for a considerable period, and consequently may be collected there. The same is also a consequence following from the insinuation of the seed from the

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[1] Paphos, a city in the island of Cyprus. It was particularly devoted to the worship of Venus.

testicles through the vasa deferentia, which takes place successively and little by little; and also from the length of time that it is kept in the vesiculæ. *For in order that the seed may serve its use for the new generation, not only quality is required, but also a sufficient quantity. Without the vesiculæ seminales, this quantity could not be had. Were the seed drawn in immediately from the testicles through the vasa deferentia and finally through the urethra into the womb, it would not produce an effect suitable to nature's laws. For if the quantity were scant, the effect would be rendered uncertain, and before it was reached, most of the seed would be volitalized, and perchance dissipated in the trabecular*[1] *structure of the urethra and in the corpora cavernosa, or else in the blood and fibres, and so likewise in the womb.* Quantity, therefore, is a desideratum, to the end that the effect may be rendered certain, and that the seed may not only line the walls of the uterus, but may also go up into the Fallopian tubes and the ovaries. This could not be the case if only a drop or two got in, which, sticking to a portion of the surface of the uterus, would there be arrested until its inner and more volatile essence was dissipated. It is therefore necessary that the seed should crowd the doors that lead to the ovaries and also that it should run through the expanded urethra, and on the way, fill in and fertilize all the adjacent parts. Moreover, were it to flow in immediately from the testicles, then, before it reached the middle of the urethra, it would be dissipated into auras. This, however, belongs to the matter of quality.

86. [SECOND.] *That the vesiculæ seminales digest the simple and primitive globules of the seed derived from the testicles, roll them about and thoroughly mingle them with grosser essences, is plain from their very structure and motive power, or from the effect itself. Thus these vesiculæ produce, and give to the seed, not only quantity but also quality.* Quantity is of no great import unless quality be also present; for it is the latter that gives the real power of prolification. A quantity of the right quality meets every requirement. *The quality consists in this,*

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[1] Bodies whose membranes are prolonged so as to form septa and thus cells and cavities, are said to be of trabecular structure. The term, therefore, applies to the testicles, the corpora cavernosa, etc.

that a quantity of prolific seed or of primitive and truly vital substance be present and within. But this bare substance when not properly disposed into its form, being volatile and easily resolvable, can perform no use unless, like the seeds of the vegetable kingdom, it be again and again enveloped with membranes. Nor can it be thus enveloped unless suitable binding substances be at hand, which shall colligate the primitive globules into grape-like clusters, as it were, and when colligated, shall wrap them round with a common tunic, and thus by repeated compositions, shall reduce them into suitable forms. Namely, according to the description of the seed, whose inmost parts, and as it were centers, are occupied by the purest substances, while the grosser constitute its surface, just as in the little seeds of the vegetable kingdom; with this difference, however, that animal seeds need to be covered only in the most delicate and slightest way, since they are to be again resolved and opened in the genital soil of the mother's womb; whereas the seeds of vegetables have to undergo the process in the bosom of the earth, and to this end, their tunics are comparatively thick, and only to be resolved by prolonged maceration and a species of putrefaction. *In order then that an abundance of fluids suitable for the formation and composition of such tunics, may run into the vesiculæ seminales, liquor of divers genera and species is derived into those vesiculæ; that is to say, from the arteries sent hither from the rectum and bladder, comes a quantity of subtly sulphureous and urinous elements; from the glands, called sebaceous glands, which beset the inner surface, a suitable and unctuous matter; from the cellular tissue of the peritoneum and bladder, liquids which are adapted for uniting these menstrua; and lastly, from the fibres that come hither through the vasa deferentia and end in the common tunic and the septa of the cells, and also from the nerves of the vesiculæ themselves, that spirit which is termed the animal spirit. Thus there is nothing absent that can be of service for uniting the seminal globules and weaving the tunics and inner forms of the seed.* That an abundant supply of arteries is derived hither from the rectum and from the whole extent of the bladder, is shown by anatomy. The arteries push on to this threshold, especially since here is their terminus and as it were haven of rest; and on the way, they deposit all those refuse parts that are too gross, and would not be serviceable for the above use. For they deposit this excrementitious portion both in the bladder and in the rectum, nor do they carry to the vesiculæ any but the purer parts of the blood and serum. All these particulars are susceptible of anatomical demonstration. Anatomy also teaches us the mode in which the arteries are inserted into the vesiculæ. Moreover, that glands emulous of sebaceous glands, sprinkle on a fatty, unctuous and viscid humor, is a consequence from the recognized fact of the existence of such glands. The best anatomists recognize this fact, and indeed have discovered a number of glands on the internal surface of the vesiculæ. That a certain liquid from the cellular tissues is also poured on, is evident not only from the continuity of the tunic of the vesicula with the peritoneum, bladder, and vasa deferentia, but also from anatomical experience; for when the vesiculæ are inflated or injected, the air or injection not only expands the vesicula of that side, but also passes into the adjacent parts of the coat of the bladder and raises them, although it does not penetrate into the bladder; see Winslow [n. 77], and other anatomists. This watery fluid also, like the blood, unloads its more feculent serosity into the bladder and elsewhere, and carries to the vesiculæ only the pure serosity. Animal spirit also is copiously sprinkled on,—nervous fibre being continued, not only from the testicles and epididymides, through the vasa deferentia, to the whole tunic of the vesiculæ and to their septa where it terminates, but also from the pelvic plexus; and whatever the fibres from these two sources carry, namely, animal spirits in considerable quantity, can be discharged nowhere else but at the end of the fibres. Thus nothing can possibly be wanting to the further composition of the seed; for whatever is at all capable of serving as a copulant or combiner is already at hand; that is to say, active spirit, a serum full of sulphureous elements, and at the same time a serum that is glutinous and subtly fatty. This, however, is not the place to consider the mode in which the several elements are copulated.

87. *But in order that these several elements may be properly combined, and each obtain its own place in a fitting manner, they require to be perpetually rolled round and round, and thor-*

oughly mingled together. And to produce this result, a gyratory motion is requisite,—a motion which nowhere in the body exists in greater perfection, or springs from more numerous causes than in these little vesiculæ seminales. For the inmost motion of all the fluid parts here, is induced by the influx of the seminal globules from the vasa deferentia, and by the spirits themselves which flow in through the nerve, and also by the other menstrua which are insinuated through their own proper orifices; moreover also by the fibres themselves, which are of a two-fold origin; and particularly by the simpler fibres which emulate a like motion as the spirits they enclose, and which, by their tremiscence, act as instrumental causes to recruit the intrinsic motion of the fluids. For in the affection and act of venery, is involved a kind of subtle trembling motion of the purest kind, which is communicated to the several nervous fibres of the whole system. And in addition to this inmost and intrinsic motion, another and more general motion is brought in by the muscular membrane which covers the vesiculæ and girds them with a tunic, and which is described by many anatomists as being of a robust structure. A motion still more general, or the most general motion, is contributed by the peritoneum and the muscles of the abdomen; for the peritoneum constitutes the outmost tunic of the vesiculæ, and communicates to them all the motion of the abdomen,—which motion is perpetual, and which is varied according to all the natural and voluntary actions of the body and lungs. Thus there are causes of motion which are particular, general and most general, all of which excite and impel the vesiculæ and the fluids contained therein, into a gyratory or circulatory motion from one cell to another, and so through a circle. This gyratory motion is in agreement with the form of fluxion of the parts,—a form which gives to the vesiculæ such a figure that they flow around agreeably to their own nature. From this it may be inferred, that the parts of the seed are here raised to their third dimension. The purest parts of the seed, which flow in through the vasa deferentia and carry an intrinsic motion into the whole mass, are the most active and mobile of all; so much so that their motion may be compared to the form of the modifications of the purer aura, being vortical and perpetually gyratory. Similar also is the motion of the fibres that set up this motion; on which subject see our Doctrine of

Forms,[1] and Modifications.[2] Every time that aught of this sperm is instilled through the vasa deferentia, a motion of this kind is brought in; at the same moment, it is brought in also by the fibres that are everywhere scattered about through the septa of the vesiculæ and added thereto. Moreover, the muscular tunic which is excited synchronously with the fibre of the urethra, penis and the other genital organs, also contributes. The peritoneum is constricted and expanded every time any natural actions exist, as, for instance, in every respiration, in throwing, in stretching of the loins and arms, in struggling, fighting, walking, running, riding, discharging the feces and urine. But since this motion is a motion of a most general kind, it does not act on the inmost parts, but kneads, presses, and rolls the seminal mass, only in a general way. From this triple motion, and also from the form of motion relatively to the form of the ducts and of the consequent circulation through the cells, it may be inferred, that the genuine sperm is raised and compounded to the third dimension. The rules of the induction are established by the rules of the Doctrine of Forms.

88. *Thus the seed is perfected and brought to maturity; that is to say, each part of it is carried to the third dimension and gets embodiment, in order to give it consistency and ensure its due conveyance through the canal of the urethra into the womb. This maturation or ripening is produced not only by the action of time, but also by the continual circumvolution and kneading of the fluids of different kinds which flow in. In these respects animal nature resembles vegetable, in that seeds require to be ripened before they can perform their use. To secure this end moreover, ripe and virile age is requisite; for in the first period of life, before the more virile years commence, the testicles and vasa deferentia pour in only the vital sperms; the next period pours on a greater abundance of juice and copulating humor; thus the seed is perfected, and is emitted more fit for generation and without the loss of the virile powers.* These particulars are intelligible by comparison with the seeds of the vegetable kingdom. They are also confirmed by the facts of the case, and particularly by the

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[1] See the FIBRE, n. 265.

[2] See n. 20, note, and consult the author's ONTOLOGY.

actual variety of the seed in respect to color, consistency, and other varieties.

89. *The seed, therefore, gets its quality in the vesiculæ seminales. This quality is of considerable variance, so that the seed in one subject is not of like quality with that in another; for it may contain less or more of vital or procreative sperm, also less or more of humor apparently seminal; or the sperms themselves may be too closely implicated and stuck in the parts of the humor, so that in the womb they can hardly be resolved; or they may be too loosely coherent with this humor; or they may be of different consistencies or groupings. These varieties are also observable by differences in color, density, quantity, and chemical composition. Moreover, in the seed are sometimes represented little insects or living corpuscles. The causes of the varieties in quality depend on the period of age, the time of the seed's ripening, the frequency of venery, the degree and state of desire, the constitution of the body, and the contingency of several diseases. It is in the vesiculæ that the seed is first changed, infected, and putrified into the matter of gonorrhea,—the sperm in the testicles, epididymides, and vasa deferentia remaining entirely uninjured. Thus all the quantity and quality of the seed is to be attributed to these vesiculæ, which on this account merit to be termed the grottoes of Venus and Cupid.*[1]

90. [Third.] *As to the remaining point, namely: The vesiculæ seminales are also the first and principal organs that by their active force excite the desire of venery and enkindle its flame. For they are extremely sensitive, and they convey to the cerebellum the state of the seed and particularly the state of its activity; and the cerebellum, excited by the caress, straightway rouses into this desire all its fibres and the whole of its nervous system. For in the vesiculæ are fibres and septa of the most delicate kind, and, moreover, a papillary or villous tunic which, like the organs of touch, perceives every vibratory touch and modification. By this perception, the fibres of the cerebrum (which are implicated with those of the cerebellum all over the body), and hence also its sensoria, are roused up; hence comes desire and pruritus.* The villous or papillary tunic which invests the inner surface of the vesiculæ, is mentioned by Winslow [n. 76.] It is the more sensitive in proportion as all corners of it are filled, particularly when a plentiful collection of seed presses out the tunics with their papillæ and intensifies the sensation. To this end nervous fibres are derived thither from the pelvic plexus. Sense can no more be denied to these papillæ than to the fibres everywhere present in the skin, especially since it is proved by the very effect. Desire is kindled into pruriency when there is a large quantity of seed (*genitura*), or when the seed is somewhat acrid and pricking. The circulation and intrinsic motion in the vesiculæ must necessarily agitate the fibres and also the septa, which are of a membranous character; but the faculty of sensation implanted in these vesiculæ seems to be of such a nature that their papillæ are sentient of the intrinsic motion of the genuine sperm, while their membranes are sentient of the more general motion. Hence results the variety of the affection, or of the effect. *The vesiculæ seminales are excited in another way, namely, by way of the external senses, that is to say, by objects seen, touched, kissed, embraced; yea, and immediately by the very imagination of such things. Hence the animus*[1] *falls prone into the affection of venery, and in this state, the fibres, both of the cerebrum and cerebellum and consequently the fibres of the whole body, are seized with a delicious and inmost tremble, and expand and contract. Such is also the case with the internal sensory organs or the cortical glands themselves. The effect at once goes down to the vesiculæ seminales where is heaped up the very matter of venery, which is straightway excited to a similar tremiscence and motion. Hence desire is aroused, and is enkindled even to pruriency; for the sensation then returns from the vesiculæ through the fibres to the cerebrum and cerebellum. Thus the vesiculæ seminales are both the first and the last bounds whence comes the venereal affection.* That the testicles are not such bounds except where there is a pure affection, that is, genuine conjugial love, will be pointed out below.

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[1] *Crypta veneris et cupidinis.* The translator has supplied the words "veneris et cupidinis" with an initial capital, otherwise the phrase must be translated, "The grottoes of venery and desire."

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[1] By the animus is meant the lower mind, formed by images entering in through the senses; the word is used in contradistinction to "mind" (*mens*), which signifies the superior mind formed by intellectual ideas.

91. *The vesiculæ seminales are also the first impulsive causes that erect the urethra and the corpus cavernosum which surrounds it, that is to say, the penis; for by the aroused motion of their enclosed seminal substance, they agitate the beginnings of the urethra, its caruncula, and the other parts, and these, vibrating with this caress or titillation, lay open the several pores into which the nervous spirit and the blood then flow without impediment; which effect is a continuation of the cause. For as the least fibres are set open by that desire, so the compound fibres are set open by a similar force, which gains increase in the vesiculæ. Thus the vesiculæ seminales are not only Repositories, but also Erectors.* We shall treat of the proximate causes of erection in the following pages. But of this proximate cause, the proximate or efficient cause is the excitation of the seminal humor; for the tunics and septa of the vesiculæ are continued through the two ducts all the way to the caruncula, where lie the accelerator muscles; and all the vibration that is impressed on the little tunics and septa of the vesiculæ passes immediately to the caruncula, whither those orifices penetrate. But of this, more anon.

92. *But the causes of the excitation of the seed of the vesiculæ into that intrinsic motion which agitates the fibres of the urethra, are many in number, being both internal and external. The causes are inmost when the cerebrum and cerebellum, roused up by objects either external or internal, act through the fibres on the vesiculæ seminales and their spermatic humor; internal or middle, when that humor is abundant or when its character is such that, on the least excitation, it rushes into a motion and pruritus of the kind; and exterior when the penis, the glans penis, or the parts continuous therewith, are rubbed,—for a similar friction then flows by continuity all the way to the vesiculæ, and the animus itself then concurs, being similarly affected.* This follows as a consequence from what was said above, for given the cause, the effect also is given.

93. *That it is the vesiculæ and not the testes that produce the erection and expansion of the urethra, is abundantly evident from the case of those who have no testicles,—whether they have lost them by excision or castration, or from any other cause,—who, nevertheless, during the erection of the penis emit a humor not* *unlike the seminal fluid. It is also evident from the stiffening of the penis in sleep, when either the fibres of the cerebellum are quite detached from those of the cerebrum and left to themselves, or the urinary bladder is distended, and, in consequence, the vesiculæ seminales become more expanded in all directions, and the seed compressed in their cells, makes a strong push for its orifices, namely the beginnings of the urethra and the caruncula.* If the testes were the efficient cause of erection, the penis of castrated persons could not possibly swell up. Nor could there be any swelling of the penis unless something like seed were contained in the vesiculæ seminales; and since this something is made up of the supply of humor treated of above, it is a sign that the efficient cause of erection lies in these vesiculæ and their inciting humor, and not in the testicles.

94. *Furthermore, the vesiculæ seminales dispose and excite to co-operation, not only their fleshy appendage, that is to say, the penis, but also the vasa deferentia and the testicles. Thus the vesiculæ act, as from a centre, both upon the parts that precede and upon those that follow. For the proximate tunic encircling the vesiculæ, and the septa of their cells, is continued from the fibres of the vasa deferentia, and hence from those of the epididymides and of the tunica albuginea of the testicles. Still this tunic cannot pass into the structure of the testes unless its intrinsic motion be that of the genuine sperm, that is to say, unless its subtle tremiscences be those of the simple fibres.* This follows from the connection of the parts. For the fibre is continued from the testicles into the vesiculæ, but not from the vesiculæ into the testes. All sensation, whence results action, is propagated to the antecedent parts of the fibres, that is, from lasts to the first; for example, from the organs of touch, taste, smell, hearing, to the cerebrum and the beginnings of the fibres. But motion is propagated to the consequents of the fibres, that is, from first ends to last; for example, from the cerebrum to the muscles. The like is the case here in the vesiculæ, the origin of whose fibres is in the testes; and therefore, the exquisite sensation of the vesiculæ goes back to its beginnings in the two testes. Still the latter are not therefore excited to action; for the efficient cause of the motion of the testes arises from the beginning of its fibres, that is, from the cerebellum,—they themselves not being the cause of their own motion. This is a wise institution for preventing the testes from breaking out into action every time the vesiculæ seminales do so, for they would then allure from the blood and the fibres an excessive quantity of spirits, and thus would exhaust the body; for which reason they are no more strongly excited than is proportionate to the strength of the desire that kindles the animus.

95. *While we are on these topics, and before going further, it may be proper to add that there are as many degrees of venereal love as there are degrees of composition in the parts of the seed, or, as there are degrees of composition in the fibres themselves. The* FIRST DEGREE *is the purest, and is the conjugial degree, which alone deserves properly to be called love. It regards no other end than that of propagation; and it is the inmost degree being the degree of the soul itself, which at no time regards the effect unless at the same time it regards the end in the effect. It excites the simple fibres, consequently the testicles themselves, immediately, and, by means of the testicles, the vesiculæ; or, what amounts to the same thing, it excites that purest vital essence which constitutes the genuine sperm. This love refreshes and renovates the nervous system, but never destroys it; for it vivifies the inmost factories of the cerebrum and cerebellum and excites them to restore the seed in a quantity equal to that which they expend. The* SECOND DEGREE *of venereal love is that which is excited, not rationally, but naturally, namely, by objects appealing through the external senses by touch, kisses, embraces, conversation, fancies. Seized with desire, it regards no other end than that it shall burn to enjoy those delights which have been insinuated* [*by the senses*] *and at the same time heightened by the imagination. This love excites, not the simple fibres, but the first compound fibres,—not the first vital essence, but the spirit of the compound fibre, which is called the animal spirit. It does not immediately invade the testes but the vesiculæ seminales, from which it is reflected to the testes; consequently, it invades, not the first, but the second composition of the seed, to the dimension whereof this degree of tremiscence is adequate. If it is called into play too frequently, and spends more than the superfluous part of the seed, it inanimates the nervous and sanguineous systems, producing lassitude, heat, cold, and other conditions, which are the*

cause of diseases arising from deficiency of the spirits. But the THIRD *or last and lowest degree of venery is lasciviousness, when it is excited by divers external causes, that is, by frictions, potions, drugs, and other unlawful means of the same sort, beyond nature's needs. This degree of venery is most highly injurious to life, and it attacks none but the grosser fibres, the blood itself, and the last composition of the seed. Irritating these to motion, it infests the organs themselves and soon destroys them; for it begins in lasts, that is to say, in the blood or arteries; and it regards no other end than lasciviousness,—and this without any previous desire.*

96. *But to resume. Because the seed of the vesiculæ seminales has sometimes too great a viscidity by reason of its long retention in these organs, and hence is sometimes rendered too sluggish and insufficiently fluid; therefore, to allow of its being vivified in the act of emission, and excited to its proper vital motion, a further means of efflux is provided from the vasa deferentia into the urethra direct. Thus the seed is so attempered and qualified that it bursts forth with fuller effect and surer use.* There is also a passage opening from the vasa deferentia into the urethra; but before entering this passage, the seed first meets the seed that comes from the vesiculæ. All dangers are provided against,—and this in order that, in the course of nature, nothing may be wanting to ensure the attainment of the end which is the propagation of offspring; for the sperm of the vasa deferentia is the vital and prolific thing which in the very act is mingled with the seminal material.

CHAPTER VI

THE PROSTATES.

97. **HEISTER.** (*Compend. Anat.*) The prostates, or more properly speaking the prostate,[1] is a single body, globose, heartshaped, situated just in front of the neck of the bladder, and completely surrounding the beginning of the urethra. Its size is about that of a walnut. At its posterior part it has two natiform prominences. In the urethra it has also an eminence called the caput gallinaginis,[2] with two little orifices which are common to the ejaculatory ducts and the vesiculæ seminales, and a little sinus frequently set between these orifices. Its substance is glandular and spongy, and is surrounded by a strong membrane. The little foramina and excretory ducts of this gland excrete a whitish humor from its little crypts into the urethra. In the human subject there are ten or twelve of these foramina; in dogs they are very numerous. The prostate has its vessels in common with the vesiculæ seminales. (n. 228.)

98. **WINSLOW.** (*Expos. Anat.*) The first portion of the urethra, or that portion which is not covered by the cavernous substance and which from the bladder to the bulb is only a simple membranous canal, is sustained by a large, moderately firm, whitish mass, of the shape of a chestnut, and situated between the bladder and the bulb of the urethra, its base being toward the bladder, its apex toward the bulb, and its sides looking upward and downward. This body is termed the prostate; it appears to be divided into two lobes, by a fissure which runs along its upper side from the base to the apex. The first portion of the urethra lies in this fissure, but it closely adheres to the mass of the prostates to which it is united. The body of the prostates lies on the rectum, and their apex is under the internal lip of the arch of the pubic bone. Their substance is spongy, but very compact. In each lobe there are several follicles which open into the first portion of the urethra toward the bottom of the fissure. (*Tr. du Bas Vent.*, n. 534-536.)

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[1] See Plate III, fig. 1.

[2] Called also the crista galli, caput galli, caruncula, verumontanum, and urethral crest.

99. The caruncula, situated at the bottom of the cavity of the first portion of the urethra, or that portion which lies within the prostates, is a longish eminence, [large on the back part, and] terminating forwards in a point; it is also called the caput galli, and verumontanum. The large portion of it is commonly perforated by two foramina, sometimes only by one, seldom by three; these are the orifices of the excretory canals of the vesiculæ seminales. Each orifice has a small thin membranous border, which can serve as a valve to the excretory ducts of the vesiculæ. On each side of the large portion of the caruncula, there are four, five or six little foramina ranged in a crescent round its lateral parts; these are the orifices of the excretory canals of the prostates. They come from the follicles, and run in a very oblique course to the orifices, in a kind of membranous duplicature. (*Ibid.*, n. 543, 544.)

100. BOERHAAVE. (*Institut. Med.*) In the place where the outlet of the vesiculæ seminales opens into the urethra, the latter is surrounded by the prostate gland. This is single, continuous, conical, environed with muscular fibres, and made up of twelve distinct glandular groups, the glands of each group terminating by their emissary ducts in a single little sac into which they pour their humor. Hence we have twelve distinct sacs, opening by as many distinct and considerable emissary ducts into the cavity of the urethra, in such manner that the orifices surround on all sides the outlet of the vesiculæ seminales. At this point, therefore, the seed and the humor of the prostate are accurately mingled, the vesiculæ and prostates being surrounded by the same muscular membrane. The humor made in the prostate is bland, fatty, white, and abundant. (n. 652, 653.)

101. MORGAGNI. (*Advers. Anat.*) The humor secreted in the prostate gland, is sometimes so much altered, that in several cases I have found it coagulated into a number of granules of a darkish yellow color like tobacco; and these I have observed, not only in the urethra at the orifices of the ducts of the prostate, but also in almost the entire substance of the latter, wherever it was cut into. (IV. § 14, p. 24.) In several dead subjects Morgagni found in the caruncula a small longitudinal sinus [situated between the ejaculatory sinuses], which presumably communicated with the seminal ducts; for when the vesiculæ seminales were compressed the seed flowed into this sinus[1] (IV, §3, p. 6).

102. Winslow. (*Expos. Anat.*) The superior prostatic muscles are two thin planes attached to the upper part of the interior side of the rami of the pubic bones, from whence they spread over the prostates into which they are inserted. The inferior prostatic muscles are small transverse planes, each of which is attached to the symphysis between the ramus of the pubic bone and the ischium, and from thence runs transversely, till it meets its fellow from the other side under the prostates, to which they are both strongly connected, serving as a girth or suspensory. They may be considered as the small or internal transversales, [and the two superior muscles as the great or external]. They have likewise some connection with the point at which all the other muscles of the urethra and penis meet. (*Tr. du Bas Ventre*, n. 574, 575.)

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[1] The sinus here referred to, is the prostatic utricle; see Plate I.

INDUCTION.

103. *In order that the vesiculæ seminales may act upon the urethra and its surrounding flesh so that it shall receive and expel the seminal humor; and that they may dispose the several parts to the effect of the end; they require the aid of the prostate gland, which must be close to them and in contact with them and must engird the orifice or beginning of the urethra; and moreover, of that little body common to both the vesiculæ and the prostate, which is called the verumontanum, caput galli, or caruncula. For instruments and organs are necessary in order that the principal cause may extend the sphere of its operation. The instrumental causes comprise all those parts that are visible in and about the urethra, the chief of which, however, is the prostate, which, besides serving the function of mediation also strengthens the first portion of the urethra and disposes it for proper action. And in the present case, such instruments are all the more necessary, since, in the dispensation of the seed, innumerable things occur, and in order to render these possible, the organs must be so disposed as to correspond to the several modes.* That the vesiculæ seminales and the prostates communicate very closely is apparent from their juxtaposition, contact, and insertion. It is also apparent that what is called the muscular coat is common to them both; and moreover, that the emissary ducts of the vesiculæ and prostate meet in one eminence, namely in the caput galli. Anatomy also shows us that the prostate completely surrounds the beginning of the urethra leaving only a fissure which affords a passage to the two emissary ducts of the vesiculæ seminales; an almost similar fissure is also found at the end of the urethra, —these two fissures communicating with each other. *For the urethra, that is, its membranous cavity, is continued from the prostate; and in this way the action of the urethra depends upon the action of the prostate, or on that of the vesiculæ seminales by means of the prostate. But since the vesiculæ seminales act pri-*

marily upon the urethra and also upon the prostate, it follows that there is some middle or third uniting body, which combines the two actions. This third body is the caput galli or caruncula; for into this caruncula, as into a common terminus, flow in two ducts from the vesiculæ seminales and several from the prostate. From this point, therefore, arises the combined action of the two bodies. That this caruncula is a kind of appendage and third or uniting body to the vesiculæ seminales and the prostate, is apparent from the insertion of the ducts of the vesiculæ seminales and of those of the prostate, which, however, enter it in different ways.

104. *The prostate also guards against anything from the vesiculæ rushing out into the urethra before the ultimate effect is reached; the caruncula also keeps like guard. For without these two organs and their assistance the seed would drip away little by little in scattered quantities before the ultimate effect alluded to, that is to say, before the act; and the end in view would be lost.* These organs are like two bars that prevent the seed from being thrown forth before it has acquired due quantity and quality. This is evident, not only from their organism, but also from the effect. For unless these bars be broken through by some force, that is to say, violently, no passage is afforded, and the knocking at the doors is fruitless. Violence is first brought to bear when they can no longer resist the impelling force. As regards the effect, there can be no room for doubt. In this place it comes to be deduced only partially, because from anatomy; but it is necessary to explore the mode [in which this effect is produced], as based on the organic conformation.

105. *The causes of excitation and propulsion are internal and external; and their instrumental causes are the vesiculæ seminales, prostate, and caruncula. The internal causes are all things whatsoever which excite the desire of venery, which causes are first called internal when they possess the halls of the cerebrum and cerebellum, that is to say, the animus. As soon as the cerebellum or its little sensories are possessed by this desire, then all its fibre from the beginning to the ends is not only opened out, but is also seized with the subtlest and purest tremiscence. From this cause results not only the discharge of the spirits, but also a similar tremiscence or internal motion of the sperm; and especi-*

ally is this the case in the vesiculæ seminales where the sperm resides in gathered store. This motion rouses up the vesiculæ and their walls and septa, imparting to them a continuous effort to rush out of doors,—an effort which is all the stronger in proportion as the supply of seed is greater. The case is not unlike what obtains in the other evacuations; as in the evacuation of the urine from the bladder, and the feces from the rectum; but in these cases, the effort is grosser, blunter, and more sensible. This is what is called pruriency for the act, that is, for coition,—as is shown by the sensation itself, and by the perceptible effort felt at the time. The case is the same whether there be an overabundance of seed or a scanty supply,—the intrinsic activity still urges it on. This activity is the result of divers causes; but of these we have treated above [n. 92]. Such, then, are the internal causes.

106. *The external causes of the excitation and propulsion of the seed, are such as spring from causes in the urethra as well as outside the urethra, and stimulate to the act. For the glans of the urethra, that is, of the penis, being papillary, is very sensitive, and when gently and softly stroked by contact with the vulva and by the repeated motion of the prepuce upon it to and fro, produces a similar but grosser effect. Simultaneously the same effect is also produced by the band under the urethra, which is continued externally around the scrotum and perineum all the way to the anus, and internally, through the urethra, to the prostate; and also by the middle partition of the scrotum.* These causes are called external, because they arise [not] immediately from the fountain-head and beginning of the fibres, but from their ends,[1] and from the last terminus of the organs. For every papilla is sensitive, and conveys its sense backwards to the antecedents of its fibres. Sensation is a touch, and touch may be likened to a tremiscence of that degree; which, because it is so pure, is not recognized as a tremiscence, but as a modification.

107. *The whole of this subtle tremiscence or modification*

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[1] *Hae causas externas dicuntur, quia immediate ab ipso fonte et principio fibrarum seu a finibus earum.* In the translation, we have amended this by inserting *non* (not) after *quia,* and by changing *seu* (or) to *sed* (but).

meets in the vesiculæ seminales and the prostate. The modification that arises from the internal cause is concentrated into the vesiculæ seminales; that which arises from external causes, into the prostate; and finally both into the caruncula, which is the means of union between the two. Thus the prostate receives the internal cause mediately from the vesiculæ seminales; and the vesiculæ, the external causes mediately from the prostate. This is confirmed by the connection of the fibres; for all the fibres that are sent by the brain towards the genital organs, are first transmitted to the testicles, from whence they are reflected through the vasa deferentia to the vesiculæ seminales; besides which, fibres from the pelvic plexus are also carried thither; thus the vesiculæ must certainly receive the last impetus of the modifications of the cerebellum. But the fibres that are extended all the way to the urethra, and, through the urethra, to the glans penis, are continued from the prostate; hence, the last terminus of the modification, or rather of the friction, of the glans is found in the prostate; that is to say, the external causes there end. Thus it is, that the tremor of the prostate is communicated to the vesiculæ, and that of the vesiculæ to the prostate, and both tremors to the caruncula.

108. *In order that the venereal desire, from whatsoever cause arising, may burst forth into act, it is necessary that the internal and external causes concur. The internal cause alone does not produce the effect; for when nature proceeds from her inmost causes to her outmost, that is, to effects, she goes by steps or degrees, in order that when she arrives at the effect, causes may be excited here also,—namely, those causes which we have called external. For no effect in ultimates is produced by the inmost cause without an orderly progression of means or middle causes.* That external causes concur to the whole effect, is plainly revealed to us when we consider the act of coition or venery. For the glans of the urethra, that is, of the penis, is then in the highest degree of expansion, and hence in the height of sensibility; and during the coition and congress this glans is touched in divers ways and soothed by all that it meets. The prepuce likewise is drawn over it backwards and forwards, and the frenum or urethra is alternately tightened and relaxed. Thus external causes are at hand which conspire with the internal to one and the same effect.

109. *Until all the causes meet and are raised to the highest power, the effect is not produced. Meanwhile the seed of the vesiculæ acts on its ducts, and the* [*humor of*] *the prostate likewise on its; but the caruncula is not opened to transmit these humors until the last force has come on; which is so violent that the caruncula is opened, that is, grants a passage not spontaneously, but by the force applied. Thus there is no gentle transmission of the seed, but an ejaculation.* These ducts are exceedingly fine, and unless force be applied, they do not transmit the least dew of moisture. And therefore the two ducts of the vesiculæ seminales pass through the naked base of the caruncula, while the ten or twelve ducts of the prostate, fine like the others, decussate with each other and by this mechanism, as it were obstruct their own passages. The ducts of the vesiculæ seminales form in the caruncula a species of valve; see Winslow [n. 99]. Moreover, the vesiculæ are corrugated and when distended can swell out to a great size and thus afford room for the urgent seed before it bursts forth. The prostate also has its appendages, called the natiform prominences [see Heister, n. 97]; so that it thus possesses receptacles apart from its follicles, which are many in number. Moreover, in some subjects, the caruncula is provided with a little sinus of its own. All which shows that every precaution is taken to prevent the seed, now exiled and conveyed to its last station, from bursting forth without the aid of an efficient cause. Moreover, if by long protracted continence a quantity of seed is collected, the vesiculæ seminales can send their superfluity back again into the blood,—for there are veins close at hand to absorb it, and, in addition, the glands conspicuous in the vesiculæ seem to be of an amphibious or hermaphroditic nature (like those visible in the intestines and skin, of which we have treated above[1]), which can either transmit the genital humor into the vesiculæ, or reabsorb it. For it is clear that the genital humor often passes back into the blood. But as to whether anything of the same kind happens in the prostate,—this we may indeed surmise, but cannot assert.

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[1] The reference is probably to preceding parts of the ANIMAL KINGDOM, see Preface. The ECONOMY OF THE ANIMAL KINGDOM does not deal with the glands of the Intestines. The reader is, therefore, referred to 1 A. K. 124 *seq.*, and particularly n. 138.

110. *To enable the seminal humor to burst forth and, as it were, to break through its barriers, there is required not only a quickened intrinsic motion of the genuine sperm, but also, and at the same time, a similar correspondent motion of its subsequent compounds; into which motion they cannot be excited, save by external causes. In addition, there is required a reciprocal action of the tunics and septa, both those that compose the texture of the vesiculæ and those that compose the texture of the prostate and its follicles. In the act itself, that is, in the last effect, there is required the force of the muscular tunic, or of the muscles which properly belong to the prostate, and are called the superior and transverse prostatic muscles. When these are called into play, they superadd a force that overcomes the resistance. Hence, in the act there is a kind of convulsion of the muscular fibres and particularly of the prostate.* For the superior muscle, attached to the pubic bone, and the transverse muscle, attached between the pubic bone and the ischium, send motive fibres over the prostate, and thereby form a kind of muscular tunic; see Winslow [n. 102] and Boerhaave [n. 97]. This tunic is also continued in a measure over the vesiculæ. Thus when these fibres act, they compress both the prostate and the vesiculæ, and this in the most powerful manner when coition is going on, that is to say, when the internal and external causes, excited to the highest degree, concur. In the healthy natural state, this force is so proportioned that the resistance is overcome, but only in the last degree of the impelling causes.

111. *The muscular fibres of the prostate are not excited to the highest degree of activity, that is to say, to the convulsion, unless, moreover, a cause be added which does not come into play except in the act itself, that is to say, by the reciprocal agitation of the pubic bone and the ischium; for by this agitation the fibres, alternately contracting and relaxing, put the utmost force of action into the muscle. Without this accessory cause of the action of the muscles, in the healthy state when there is a natural resistance, no effect would follow; for this force it is that overcomes* *the resistance or the reactive force.* I do not intend in this place to treat of the causes of the action of the muscles; but it should be mentioned in passing, that these causes are internal and external,—the internal springing from the very beginnings in both brains, and the external arising in the body itself, namely by frictions and subtle tremiscences; just as is observed in the phrenic nerve, which when subjected to friction, excites and constricts the whole diaphragm.[1] Moreover, touch applied to the muscular fibres of the heart and stomach, even after the parts have been cut away from the body, affords the same phenomenon,—as innumerable experiments testify. The like may be said of traction,—as again proved by many trials; for when traction is applied to a nerve, the muscle is powerfully contracted. In the present case, this is effected by the above mentioned agitation of the person. *The fibre expands and swells out under sweet and soothing friction; and as the fibre swells, so it is shortened or diminished in extent; hence the muscle is then contracted, and acts on the space that it encloses. This is the reason that while the intrinsic motion of the fluids and the blandly tremulous motion of the fibres is going on, the whole of the motive fibre around the prostate and vesiculæ seminales is contracted. Thus, from causes internal and external, all the fibre of these organs acts on the enclosed liquid and urges its escape; not however to such a degree that the reaction will be overcome until the local agitation of the bones of the pelvis comes in aid.* But these points will be explained more clearly further on, as well as in the chapter on the Muscular Fibre.[2]

112. *In order then, that the act of coition may not be hindered by the act of evacuating either the bladder or the bowels, particular provisions are made. Thus it is provided that the prostate shall lie on the intestine; and the intestine is so bound to the bladder that the two cannot act simultaneously. For when the rectum swells up, as during evacuation, the prostate is pressed but not the vesiculæ seminales, and then all the motive fibres of the muscles are relaxed, so that there is no action of the tunic or of the individual fibres upon the prostate and vesiculæ, but only*

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[1] See A. K. 449 notes y and z.

[2] No such chapter is included in the work on the FIBRE, nor, so far as we know, is any mention made of it; see PERIOSTEUM, n. 5, note.

a general action, whereby no libidinous excitement is produced; and therefore also, we then push the pelvic bones forward, but in the act of venery the pelvis is allured backwards.

113. *The humor that escapes in abundance from the prostate (which is a gland), and is sprinkled into the urethra, is accurately commingled, close under the caruncula, with the spermatic humor that flows in from the vesiculæ, and with that pure sperm that flows into the urethra immediately from the vasa deferentia.* For the ducts of the vesiculæ seminales pass through the caruncula; likewise also the ducts of the vasa deferentia, which combine with the former; but the ducts of the prostate, to the number of ten or twelve, pass through a particular membrane, and being disposed about the sides of the caruncula, they cannot elsewhere vomit their humor than immediately beneath it. It must necessarily follow, therefore, that the two humors are accurately commingled. *And this in such fashion that the humor of the prostate is scattered about over the whole circumference of the urethra lying immediately beneath it, and lines the entire wall of its cavity; while the seed or genital humor holds the middle place and cannot leap against these walls until it has first mixed itself in with the humor of the prostate.* For the lateral ducts scatter their humor to the sides, but the middle ducts to the axis; so that the seed cannot possibly touch the walls unless it first passes through this humor. Nature appears to have guarded against this contingency by the obliquity and decussation of the prostatic ducts; for they run obliquely, and on the way, they intersect each other, see the writers on anatomy. Hence, when this humor is violently injected it is carried in these directions, that is to say, round all the sides, by way of circumgyration. *Wherefore, this humor, which in itself is bland, milky, fatty, and abounding,—not unlike the humor excreted into the vesiculæ seminales from the arteries,—at once absorbs, envelops, and enfolds the seed of the vesiculæ and vasa deferentia, lest any portion thereof that is not yet sufficiently compounded, formed and ripened, should impinge upon the walls and be resolved back into its primitive and volatile essence; or should fall into the veins and little pits of the urethra, and thus be lost; and in order that all the genuine sperm enfolded in this humor may be safely carried through the whole urethral canal to* *the place of exit, and thus show forth its destined use.* This humor is similar to the humor excreted by the arteries into the vesiculæ seminales. For the arteries are the same for both organs, and spring from the same trunk. Hence the humor is homogeneous, that is, of a quality exactly suited to the seed. The sperm that passes from the vasa deferentia immediately into the urethra is not yet full grown or entirely formed, but is virgin, tender, pure, volatile; and unless it were instantly enfolded in the humor of the prostate, then, at the least contact with the urethra and its walls,—which are variously hollowed out, and therefore perhaps, befouled with the residue of the urine,—it would at once be resolved and dissipated. There is also a similar sperm in considerable quantity in the vesiculæ seminales, for that which has recently come into them cannot yet have been brought to its right state; and this also, unless so enveloped, would likewise fly away; for where there is an intrinsic motion, there solution and the change of many parts is going on. Again, if by excessive delay and prolonged rest, the seed be too much condensed, it is at once irrigated by this moisture and suitably dissolved. This humor therefore, is not only the vehicle of the seed, but is also its conserver and restorer. It also increases the quantity, being itself copious, and much more abundant than the seminal humor coming from the vesiculæ. Thus the seed emitted from the vesiculæ, on meeting this humor does not fall into any empty cavity. Without this enfolding humor the very small quantity of sperm emitted from the vesiculæ seminales would be dissipated without effect, even in the womb, where it would be absorbed by its lacunæ and veins before ever it came in contact with the ovaries. The afflux of this humor appears to be so great, particularly in the act, as to make it the largest constituent of the seed (*genitura*). Without it, repeated acts could not so frequently take place; for no greater quantity [of humor of this kind] runs into the vesiculæ seminales than suffices for the supply of the sperm, the remainder being reabsorbed. In what has been said, it has been my wish to give an idea of the utility of this humor.

114. *If we properly consider the operation of the prostate, together with the co-operation of the vesiculæ seminales, it may* *appear that this humor of the prostate runs before the humor of the vesiculæ, in order, like a bride, to be ready in its bed to receive the bridegroom.* This follows from the connection of the active forces of which we have already spoken; for the prostate is furnished with muscles and is compressed by a muscular coat direct; not so, however, the vesiculæ seminales, which appear to borrow their muscular coat from the prostate. Hence, this coat is everywhere more present and stronger on the latter, and also prior,—and this in order that the prolific or fruitful seed may not slip away. So perhaps this humor also rushes out first, that it may hospitably receive the approaching seminal humor. Thus all the means that can possibly be required for the right attainment of the end are provided with the utmost wisdom.

115. If there be a sinus in the caruncula, according to the observation of Morgagni [n. 101], the seed tarries there also before being expelled. A sinus however, appears to be formed by interrupted coition, when the seed pushes forward into the ducts but is not emitted; hence often gonorrhea.

CHAPTER VII

THE URETHRA.

116. HEISTER. (*Compend. Anat.*) The urethra[1] is a membranous, nearly cylindrical canal, continuous with the neck of the bladder, and reaching to the extremity of the glans penis. It is situated in the groove formed on the lower side of the penis by the interstice between the two corpora cavernosa. It is not a straight tube, but is bent in a remarkable manner. It is twelve or thirteen inches long. Its calibre is about equal to that of a goose-quill. It is made up of two robust membranes, between which lies a spongy or cavernous substance wherein, according to some anatomists, are found minute glands. The bulb or protuberance, is that part which lies next the prostate. It is thicker than the rest, an inch long, bears some resemblance to the bulb of a small onion, and is of a thickish spongy texture. The inner surface of the urethra exhibits various little foramina, round and oblong, and also little canals, from which in many cases a viscid liquid may be expressed which lubricates the urethra. (n. 229.)

117. It has three mucous glands called Cowper's Glands. Two of these, situated one on each side of the urethra, lie between the accelerator muscles[2] and the bulb, are of an oval figure, a little compressed, and about the size of a small bean. They convey a clear mucous liquid into the urethra by a particular excretory duct nearly two finger-breadths long, and which perforates both the coats of the urethra. (Heister himself has not found these glands as large as described by Cowper, and he doubts whether they are always present. Morgagni indeed affirms that he has found them in most subjects, and sometimes as large as a small kidney bean. *Nota*, 29.)

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[1] See Plate III.

[2] The *accelerator urinæ*, also called the *ejaculator seminis*, the *compressor bulbi* and, from its origin and insertion, the *bulbo-cavernosus;* see n. 124.

Cowper's third gland[1] is said to be situated in the angle formed by the curvature of the urethra under the pubic bones within the spongy or cavernous body of the urethra, and is figured as lentil-shaped; but Heister himself has not been able to find it. Littre's gland lies between the two membranes of the urethra just in front of the prostate; is of a dun red color; an inch broad, and two lines thick; surrounds the inner membrane of the urethra like a girdle; and perforates it by a number of minute mouths through which a mucous liquid is supplied. (n. 230–231.)

118. The vessels of the urethra and penis, are: 1. Arteries from the hypogastric and pudendal arteries. 2. Veins provided with valves; but in the penis, and later, under the pubic bones, they form surprising anastomoses called by Santorinus the labyrinth. The nerves come from the last nerves of the sacrum. There are also lymphatic vessels. (n. 232.)

119. WINSLOW. (*Expos. Anat.*) The *Urethra* is the third of the spongy tubes which make up the principal part of the penis. It closely adheres to the corpora cavernosa through the whole length of the inferior groove formed by their union. It differs from the other two, both in being narrower, and in forming a canal. In substance, it is spongy and cavernous, except a small portion next the bladder; its inner and outer surfaces, or convexity and concavity, are membranous. It is at first no more than a membranous canal continued from the anterior opening of the bladder, which is called the neck of the bladder,—a name that would be more proper for this first portion of the urethra. About one and a half finger's-breadth from its origin, it encounters a spongy substance like that of the corpora cavernosa, only finer, which surrounds it through the whole extent of the inferior groove of the corpora cavernosa. *The Bulb.* This spongy substance does not at once surround the urethra, but first forms an oblong body like a pear or onion, which is attached only to the lower convex surface of the canal, but afterwards splits in two and completely engirds it. This body is called the bulb of the urethra. It is larger than any other part of that canal. Interiorly it is divided into two lateral parts by a very fine membranous septum, and therefore, when inflated, it appears double or with two heads. (*Tr. du Bas Ventre*, n. 530–533.)

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[1] The name, Cowper's Gland, is now generally confined to the two glands previously described in the text. The third, which lies in front of and between Cowper's glands, is found only occasionally, and is sometimes called the *anterior prostate*, or *anteprostatic* gland,—though these terms are also applied to designate Cowper's Glands.

120. *Lacunæ.* The inside of the urethral canal is beset with innumerable capillary bloodvessels of the finest kind. It is also perforated by a great number of longish foramina and lacunæ, some of which, especially those near the glans, are more conspicuous than the rest. These lacunæ are the orifices of the minute excretory ducts of the same number of small glands which are dispersed throughout the substance of the urethra. The excretory tubes sometimes run for some distance in the spongy substance along the convex side of the internal membrane of the urethra, and open obliquely into the urethral canal. The edges of the lacunæ are semilunar or crescentic by reason of the obliquity of their openings. (*Tr. du Bas Vent.*, n. 553–554.)

121. *Anteprostatic glands.*[1] A little way from the beginning of the spongy substance of the urethra, we meet with two lacunæ larger than the rest, and whose ducts are quite long. They lead from two glands situated on the two convex sides of the cellular substance of the urethra near the bulb. Each of them is about the size of a cherry-stone, but somewhat long and flat. They are entirely surrounded by the accelerator muscles. There is a third body of the same kind [situated more anteriorly]. (*Ibid*, n. 555.)

122. The *Cavity* of the urethra is not everywhere round. Towards the glans it becomes broader as well as flatter on each side, especially in the glans itself where it forms a kind of oval or navicular fossula. Its extreme orifice or fissure is much smaller than the rest of the cavity. It seems to be surrounded by fleshy fibres. (*Tr. du Bas Ventre*, n. 556–557.)

123. *Glans.* The cellular substance of the urethra [having reached the extremity of the corpora cavernosa] forms a large head called the glans, which is the common capital of the three spongy pillars; it is, however, a continuation of the spongy substance of the urethra [and adheres to the extremity of the corpora cavernosa without any direct communication therewith]. If it be inflated, the glans and bulb swell up, but not the corpora cavernosa; if, however, one of the latter be inflated, the air passes immediately into the other, but not into the urethra and glans. The circumference of the glans at its base is somewhat greater than that of the corpora cavernosa. Its spongy substance is dense and uniform next the corpora cavernosa, but around the urethra it is no denser than the urethra before the formation of the glans. The canal of the urethra does not lie in the middle of the glans, but passes through its lower side. The whole convexity of the glans is furnished with a fine villous substance which is very sensitive and is covered by a fine membrane resembling the red part of the lips. The circumference of the base of the glans has a double row of fine papillæ, which may be regarded as sebaceous glands. (*Tr. du Bas Ventre,* n. 537-542.)

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[1] Winslow here refers to the two glands of Cowper.

124. *Muscles.* The bulbo-cavernosi or accelerator muscles form first of all a penniform muscle by means of a middle tendon attached to the lower part of the interosseous ligament of the pubic bone and to the union of the transverse muscles [of the perineum] with the cutaneous sphincters of the anus. From thence they pass in an expanded form under the bulb of the urethra, covering both bulb and urethra and adhering in some measure to both, as high as the origin of the suspensory ligament,—the middle tendon answering to the septum of the bulb. Afterwards the two fleshy planes separate, and run obliquely right and left, upwards and forwards, embracing the two corpora cavernosa [in the sides of which respectively they are inserted]. The middle tendon adheres very strongly to the lower part of the septum of the bulb, in which, and in the urethra itself, several of the fibres of these muscles are attached. The transverse muscles [of the perineum] run from the pubic bone and the ischium to the prostates, where they meet, and form commonly a kind of digastric muscle, the middle of which gives a common point of insertion to the muscles of the urethra and to the cutaneous sphincters of the anus. (*Tr. du Bas Vent.,* n. 571-573.)

125. [*Vessels.*] The arteries come principally from the internal iliac or hypogastric arteries, and some also from the external iliac and the crural.—At the arch of the pubic bone a venous plexus is seen, which covers the upper convexity of the first portion of the urethra before the latter is surrounded by the spongy substance. It comes from the union of the hypogastric branches. (*Tr. du Bas Vent.*, 576, 581.)

126. BOERHAAVE. (*Instit. Med.*) The cavernous substance of the urethra is thickest between the end of the prostate and the union of the corpora cavernosa; afterwards, it is thinner through the whole of its course, but again thickens at the fore part of the penis, where it constitutes the exterior spongy surface of the glans, terminating in a raised border or rim about the connection of the prepuce. (n. 654.)

127. MORGAGNI. (*Advers. Anat.*) [Morgagni has observed on the upper wall of the urethral canal a number of foramina arranged in a line lengthwise to the urethra. They are rarely more than ten or eleven in number, or less than three or four, and the largest of them is usually that which is situated nearest the orifice, from which it is distant about an inch. These foramina are never so large but that they can be covered by a grain of wheat, and are rarely so small as not to admit a bristle. They are elliptical and sometimes triangular in shape, and are extended forwards longitudinally in the direction of the urethra. When pressed, they emit a whitish, thick, and sluggish liquor exactly like the liquor of Cowper's glands. If the finger be pressed above the foramen and drawn downwards [*i. e.* towards the orifice] drops of this liquor will be squeezed out; but not so readily if the finger is pressed below the foramen, or at its sides, and drawn towards it. In like manner, if a style or bristle is forced through the foramen upwards, it passes with great ease; but not so if the direction in which it is pushed be downwards [*i. e.* towards the glans], or sideways. Therefore, these foramina run for the most part in the same direction as the urethra. They are set, not in the lower, but in the upper wall of the urethra. Canals stretch from these foramina directly under the internal membrane of the urethra, and are of various lengths. On opening the largest of them lengthwise, they were found to be lined with a membrane like the urethra, which in its turn, was pierced by foramina, which expressed into the canal a liquor similar to that just described. Besides these larger foramina and the particular foramina within the ducts], Morgagni mentions having seen innumerable minute ducts and foramina in the urethra [which pierce it at the sides of the large foramina and sometimes above and below them] (I, § 10). Morgagni observes that the ducts or canals are the first seat of virulent gonorrhea; and indeed, the larger ducts,–as he found to be the case in three or four of his patients, who felt the first pain in that part of the urethra where the largest of the little canals are generally found, namely, an inch from the urethral orifice (IV, § 9). He also speaks of other little canals which run into the larger ones (Index s. v. *Urethra*) [and observes that as the mouths of the latter are always found in the upper wall of the urethra, so the smaller canals within them are always found in the upper part of the larger canals, and run longitudinally in the direction of the urethra. A bristle inserted in one of these little canals takes a horizontal direction towards the prostate gland] (IV, §17, p. 31). He speaks also of the description of the glands given by Terraneus (IV, § 7 *seq.*).

INDUCTION.

128. *As the prostate is prefixed in a general manner to the beginning of the urethra, so it is succeeded by that thick substance, termed the bulb, stretched out in front of the spongy or cavernous substance of the urethra, with which the prostate and the prior or membranous part of the urethra communicates; and by the bulb, it is continuous with all the urethral substance down to the glans; by the bulb, also, it is likewise connected with all the substance of the penis, that is, with the corpora cavernosa. Thus the bulb is the means of union and communication between all the parts comprised in the whole of this member. It does not at once encircle the urethra, but, pyriform in shape, runs from the region of the prostate to its seat, where it unfolds, and surrounds the beginning of the urethra. Its motive or muscular membrane it takes from the accelerator muscles, whose fibres it afterwards transmits outwards, forwards, backwards, and on all sides, to the corpora cavernosa.* In this place the whole active force of the prostate and the neighboring parts, and of the entire urethra, spreads itself over the substance of the whole member; more immediately, it spreads itself around the urethra itself, to which the muscular fibre above referred to is adherent, and almost enters into the [urethral] membrane. In order then, that no part of the bulb may be out of the reach of these invading forces this muscle is attached to the septum which divides the bulb into two; and from here it enters into the whole substance of the bulb, and from this substance into the whole penis and its spongy substance. For it is attached to the suspensory ligament, where all the forces are concentrated, and at the same time it pours itself into that substance in a detailed manner. *Wherefore the bulb is the terminus or goal whence issue all the active forces, both those from the prostate and vesiculæ and those from the cavernous canal and glans of the urethra. From this goal there is then an extension into the whole circumjacent substance, which determines and concentrates all its vibrations towards this common bond under the urethra, as* *towards a genuine axis.* Nature is always like herself. Where she pours forth forces, she always determines them to some central axis; as is the case in the whole body, in the several muscles, in the testes, and everywhere else; see above [n. 38]; otherwise, she would never be able to institute any of her games in a distinct manner. For she passes from particulars to generals, and from generals to most generals; thus, from one degree to another, that is to say, according to order. Judgment respecting the determinations of forces must be made from the continuity of fibres and substances; for there are no forces where there are not substances. Thus it is from the connection of substances, that judgment must be made respecting the determination of forces through the urethra and around it. *Thus the bulb is a kind of bridge that connects the testicles, vasa deferentia, vesiculæ seminales, prostate gland, caruncula, and the membranous part of the urethra, to the several parts that succeed them and lie around them,—and this, by means of fibres and membranes of different orders. All the modificatory vibrations, therefore, both those that pass from the antecedents and those that pass from the consequents, continually pass by this bridge distinctly into all the neighborhood; by which means, therefore, no part of a vibration or modification once begun can fail to arrive at consciousness.* The same vibrations pass, indeed, from all points of the urethra and its membrane and fibre, and from the vessels round about, into the substances of the penis, but in a general manner, and indistinctly. To produce distinctness and thus conformity to rules and enduringness, there must be a starting-point, a field or course, and a goal. The starting-point is the bulb, the course is the entire penis, the goal is that ligament under the urethra, where the three cavernous bodies all meet together. Besides these, there are also several secondary and particular starting points, goals, and courses, for the exploration of which ages would barely suffice. They are easily recognized, however, from the general rule; for what nature is in great things that also is she in things lesser and least, with a difference of perfection in form, determination, and every quality and effect. *It is then the more necessary that all things be here done with the utmost distinctness, since upon this depends an effect so necessary* *as the generation of the race, and since this effect requires the suitable disposition of all the parts,—a disposition which is here obtained, solely by a kind of subtle and imperceptible vibration of them all, and their consequent opening, constriction, and extension.* But of these subjects, we shall treat more in detail later on, when we come to speak of the corpora cavernosa.

129. *Humor and mucus in large quantities, not only from the prostate gland but also from several other glands of some considerable size lying between the two membranes and within the cavernous substance of the urethra, flows into this seminal and urinary canal and adds itself especially to the effluent seed* (genitura). *For a large number of excretory ducts and lacunæ are visible, and innumerable lesser orifices which are scarcely to be seen by the microscope unless the urethra be stretched.* Cowper found three glands of the size of cherry stones, each with its excretory duct; and Morgagni confirms his account, although others have looked for these glands in vain. Littre, moreover, found another gland almost environing the circumference of the urethra. Terraneus and Morgagni describe innumerable and almost imperceptible orifices through which a continual moisture transudes; there are also found lacunæ of divers forms, elongated, oval and rounded [n. 127]. *For where there are not glands visibly grouped into a mass, there are still sources of supply for this humor. For when any artery has filled its vein with blood, and the blood cannot get out from one or the other, such artery then maintains a state resembling inflammation and obstruction, as it were; in which state, agreeably to the universal custom in other members and in muscles, a copious mucous serum is excreted, which is determined through the minutest ducts, either into some larger common duct, or immediately into the grand duct, that is, the urethra. Thus, if there be no glands, nevertheless, there are at hand as many similar springs of mucous serum as there are extremities of the serous ducts of the arteries.* These numerous orifices or oscula can originate only from the arterioles and their little gyres and circumvolutions in the fine cavernous substance; for the like occurs here as in obstructed and inflamed members and muscles. The fact that an obstruction does exist, and of such kind that the arterial blood cannot be discharged except into the veins, and that the venous blood cannot be discharged at all, is a point which will be established presently. There is, therefore, no need for glands; which may, or may not, be present; for these springs or sources may be multiplied, and may abundantly compensate for the absence of glands.

130. *A humor of this kind appears to serve rather for the use of the outpouring seed, than for that of the urine; and for lubricating the walls of the urethra and guarding against the acrimony of the urine. For it has scarcely any power of coming forth, when the penis is relaxed or flaccid; but when the urethra is on the stretch and the cavernous substance is erected, and when likewise the vessels and excretory ducts are stretched forward and their orifices and lacunæ thus drawn open, then it rushes out, and sometimes visibly runs before the genuine seed.* If glands be present, they are still excited to action only during the general erection of the member, or when the neighboring vessels and fibres, including the muscular fibres, begin to act,—which does not happen when the urethra is relaxed. In this latter case, the ducts are folded together and block up their own passages, and the orifices or lacunæ close up; for, by the meeting of their borders, they produce a kind of semilunar valve. The same thing is proved by the effect; for when the penis has been long on the stretch and the ardor of desire is felt, a humor oozes out, which like the humor of the prostate, runs before the seed.

131. *Throughout the whole length of the urethra, this humor sprinkles the seminal humor, and not only produces a sufficient quantity therein and serves it as a vehicle, but also diligently hinders the seminal essence from being poured around, and from leaping up against the walls of the urethra and being absorbed by the so numerous veins and little mouths seated therein,—obliging it throughout the whole urethra to maintain the middle axis. For whatever is purest and most noble, is also inmost and occupies the center. In this, the case is the same in the general as in all the particulars.* This is the common rule in universal nature. Order itself prescribes it,—as may be seen in our Doctrine of Order.[1] That the cause may constantly give forth the effect, it is necessary that this noblest essence keep the central axis, both while it is passing through the urethra and also when it falls into the womb. Otherwise, were it thrown out to the circumferences, it might easily be lost and the effect thus be rendered uncertain. Moreover, the purest seed does not of its own accord run out to the circumferences, for it excels all other essences in mobility; and therefore, to prevent it from being determined elsewhere by necessity, it is besprinkled from the very first orifice of the urethra, that is, from the caruncula, with a humor which forbids its approach to the walls; just as in the case of the prostatic humor, as shown above [n. 113]. The same phenomenon is still more visible in the several arteries or arterial canals; for the better blood there keeps to the axis, while the viler blood and the serum possesses the circumference; see Transaction I.[1]

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[1] The DOCTRINE OF ORDER was to form part of Transaction V, see above, n. 20, note; but no work of this title has been found among Swedenborg's MSS. In the second volume of the ECONOMY OF THE

132. *Moreover, this mucous humor attenuates the seminal humor in case the latter be too thick, and thickens it if it be too thin, imparting to it consistency and temper, that it may serve its use in the womb.* This humor is not watery, but is slightly viscid and coherent, or of a middle nature between glue and pure water. It therefore tempers the too thick seed which, by remaining too long in the vesiculæ seminales, has become somewhat dry; and it also condenses the more fluid seed which has not yet been ripened by due delay in the vesiculæ. That the nature of this humor approximates to the nature of the seminal humor, is evident from the fact that venereal gonorrhea attacks with its poison, first, the juice of which we are speaking, then the purer blood, and finally the seed of the vesiculæ, see Morgagni [n. 73]. This would not be the case were there not an affinity between them.

133. *There are innumerable impulsive causes that urge on the progress of the seed and humor to the outlet; for there is not a fibre, a bloodvessel, a part of a membrane, an excretory duct into the urethra, nor a part of the humor or of the seed itself, that does not augment and determine the motion, so that the seed shall break*

ANIMAL KINGDOM, n. 210, he identifies the Doctrine of Order as the, "Doctrine of Series and Degrees," a full exposition of which doctrine may be seen in the Introduction to Rational Psychology in 2 E. A. K. 579 *seq.*

[1] See 1 E. A. K., 47.

out by way of ejaculation. That there is not here a simple transmission, but an ejaculation, is evident from the very effect. How the several parts contribute to the production of this effect, will require to be demonstrated of these parts one by one. *The whole venereal affection or desire induces a certain universal change on both the nervous and the sanguineous systems, and consequently on the whole body, and especially on the organs devoted to generation. For it not only opens the several fibres, but also brings them into a most subtle and pure vibration and modification, which, however, by reason of the exceeding swiftness of its moments, is imperceptible. This modification is of the inmost kind and invades the simpler fibres, and consequently all those fibres, of which not only the testicles, but also the vesiculæ seminales are compounded, and, moreover, the membranes of the urethra, and the cavernous substances. To these latter is added another and grosser modificatory vibration, which results from the touch of the glans and of its villous cuticle and papillæ, and which insinuates itself into the urethra, and likewise into the cavernous bodies. Since, therefore, the whole substance of the penis and urethra, and of its appendages is carried away into a similar vibration, so also the genuine sperm and the seminal humor formed therefrom, is carried away into a similar vibration or intrinsic motion. This is the cause of the state of activity of the whole seminal material; for according as is the state that lies in the tunics and their fibres, such also is the state communicated to the enclosed fluid, since the two mutually and exactly correspond to each other.* Of these subjects, we shall treat more fully in what follows. *When, from the causes just mentioned, this motion is communicated to the fluid parts, a determination is required, or a force determining these parts to their outlets. For when the fluid parts are set in this intrinsic motion, nothing more is required than a determining force to enable them to rush on with the impetus they have already acquired. The determinant forces are as many as are the excretory ducts, all of which run from the prostates, along the length of the urethra, towards the fissure at its terminal orifice. The two seminal ducts direct their course thither; the ducts of the prostate pass around the caruncula into the cavity of the urethra; the ducts of the other glands are extended forwards, lengthwise to the urethral membrane,* *for some inches, and where they issue forth, they pass obliquely and end for the most part in oblong lacunæ and canals,—as is also the case with the other innumerable and less perceptible ducts. When these ducts unanimously sprinkle their humor into the urethra, they determine it to the next following parts, that is to say, forwards. Thus, as many as are the little mouths, and as many as are the dews issuing therefrom, so many are the forces determinant in the direction of the urethra.* That these ducts run under the membrane of the urethra for the distance of an inch before coming to their outlet, is confirmed both by anatomists and by ocular inspection. Cowper's glands extend their ducts to the length of two inches; and the other and smaller ducts are extended in a similar direction,—as was clearly observed by Morgagni by the insertion of a bristle into them [n. 127]. The lacunæ, likewise, attest this by their oblong form. Hence, all the humor expressed from them is carried into the urethral canal quite obliquely, and thus determines every little part of the canal in a forward direction. We may imagine the same thing with respect to any mucous fluid running through a canal; if there be innumerable points that urge the volume to one quarter, it cannot fail to be determined thither. The force moreover, is greatest if it runs in, not so much obliquely, but almost horizontally. From the forces thus multiplied throughout the whole circumference, inevitably results the determination of the volume,—a volume which is already set in the effort to fluxion; so that nothing is wanting but the determination.

134. *Every humor of this kind that flows into the urethra rushes in with a certain force; for it does not burst out from its ducts until the reactive force is conquered by the active force. This was demonstrated of the humor that bursts forth from the vesiculæ seminales and the prostate* [n. 109–111]. *It is the muscular tunic and the reciprocal act that finally overcomes the resisting force. The same thing occurs also in the several ducts and tubules that creep along the membrane of the urethra from the glands or arteries. For when the urethra is put on the stretch and these ducts are drawn forwards, the latter are not opened until a superior force comes on, which is strong enough to open these little canals. Thus, wheresoever in the urethra any humor escapes, it is pressed* *out, and by an overwhelming force, urges on the surface of the little volume; and thus the volume is pushed on from every point, and is impelled to flow out, not gently, but swiftly; that is to say, it is ejaculated.* The less power is required for this end, inasmuch as the sperm itself, which is intimately enclosed and keeps the central axis, is volatile and mobile on its account. *This determinative and impulsive force is increased according to the magnitude of the volume, that is to say, near the extreme fissure of the urethra, which likewise resists a little; for it is seen to be surrounded by muscular fibres. Wherefore, with all these causes to urge it on, the seed may be said to be not simply transmitted but to be ejaculated.* The cavity of the urethra is larger and more capacious at the beginning; afterwards it decreases in size; but towards the glans, it again enlarges, and soon afterwards, near the outlet contracts,—and this to the end that it may burst through the door with the more violence and in the ratio of the magnitude of the volume that is urging it on. There is no muscular compression of the urethra, but rather an opening up, together with extension; and therefore the force of this eruption is produced by more hidden causes, namely, by those that produce the forces of speed and fluxion in similar bodies and fluids. But respecting the active force of the urethra by reason of vibration, we shall have to confirm its existence presently. All this force coming from the entire bulk of the penis, is concentrated upon the urethra.

CHAPTER VIII

THE PENIS AND CORPORA CAVERNOSA.

135. HEISTER. (*Compend. Anat.*) The common integuments of the penis are the cuticle and the cutis. The *prepuce* is a duplicature of the skin covering the glans; at its lower part is the frenum; both are beset with nervous papillæ and with glands, or more properly speaking, follicles, termed glandulæ odoriferæ. The *tunic* proper to the penis is robust, of a tendinous character, surrounds the other substances of the penis and is sometimes double, with an interposed cellular tissue which is conspicuous after inflation and drying. The two *corpora cavernosa* or spongy bodies constitute the chief bulk of the penis. They are separate from each other in their origin, arising on each side from the pubic bones from a kind of peculiar beds; coming together, they then extend all the way to the glans. If liquid or air be driven into them, or if they be injected with mercury, the penis becomes stiff and swollen. The *septum* or partition between the two corpora cavernosa arises from the juncture of the walls of those bodies. Behind it is comparatively thick; in front, it is thinner and is perforated like a sieve. The *ligament of Vesalius*[1] is the ligament which joins the penis to the symphysis of the pubic bones. (In one subject, Heister found also two lateral ligaments which arose from the pubic bones on each side just above the origin of the erector muscles, [and were inserted into the sides of the corpora cavernosa above the insertion of the same muscles]. But he found these ligaments in only three cases, *Nota* 28.) The *muscles* of the penis serve principally for its erection. Its *vessels* are remarkable for their abundance and distribution. Its *glans* or balanus has a smooth polished surface, and by reason of its nervous papillæ is extremely sensitive. Beneath the termination of the urethra is the frenum. The posterior circumference of the glans is called the corona, underneath which lies the neck. Some anatomists state that there are little glands on these parts, Santorinus says that these are little orifices or ducts. The substance of the glans consists of epidermis and a cavernous body which is continuous with the urethra. (n. 229.)

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[1] Called also the Suspensory Ligament.

136. Winslow. (*Expos. Anat.*) The integuments of the penis are three or four in number. The first is the cutis with the epidermis; the second is the ordinary cellular membrane which here seldom contains any fat; the third is termed nervous; and the fourth is a particular cellular membrane which is not always to be found.

Prepuce and *Suture.* The first of these integuments is the cutis or skin which is a continuation of the skin of the pubes and scrotum. It adheres to the second integument all the way to the base of the glans where the second ends. The rest of the cutaneous integument covers the glans without adhesion, and terminates by an opening. This portion is called the prepuce. Along the whole lower side both of the whole integument in general and of the prepuce in particular, runs a suture which is continued from the perineum and scrotum. The inner surface of the prepuce is lined with a very fine membrane. This membrane is folded from behind forwards round the glans, forming the proper membrane thereof and covering very closely, in the way of an epidermis, its villous surface as far as the orifice of the urethra, where it joins the membrane which lines the inside of that canal. This membrane proper to the glans, and the internal membrane of the prepuce, form by their juncture along the flat part of the glans from its base to the orifice of the urethra, a membranous duplicature which, like a septum or mediastinum, divides this part into two lateral portions, and limits the motions of the prepuce over the glans. For this reason, it is called the frenum or bridle. The internal membrane of the prepuce discharges a fluid which prevents it from adhering to the glans; and perhaps serves likewise to dilute that which is collected at the base of the glans and which comes from the sebaceous glands. (*Tr. du Bas Vent.* n. 558-562.)

Suspensory Ligament. The third common integument, improperly called a nervous membrane, is of a firm elastic ligamentary structure the fibres of which are sometimes of a yellowish color. It invests the corpora cavernosa and urethra from the glans to the symphysis pubis, and at some distance from these bones it forms on the upper groove of the corpora cavernosa a close duplicature, and by this duplicature a flat broad ligament whose plane runs directly upward and is inserted along the above mentioned symphysis as far as the tendinous base of the pyramidal muscles of the abdomen. This ligament has been called the elastic ligament, because it yields and recovers itself; and the suspensory ligament, because it sustains these parts as though they were suspended. It sends off, on each side, a detachment like an ala or wing, one edge of which is fixed between the triceps muscle and the corpus cavernosum, forming the ligamentary expansion wherein is inserted the dartos. It seems likewise to send down another elongation directly to the perineum and anus. The fourth integument of these parts is the tunica cellulosa of Ruysch, which immediately surrounds the corpora cavernosa and urethra, lying between these three columns and the third integument, from which latter it seems to be distinguished only by the closeness and fineness of its texture. It is sometimes hardly perceptible. (*Tr. du Bas Vent.* n. 564–566.)

137. *Muscles.* The erector muscles or ischio-cavernosi, lie along the roots of the corpora cavernosa, each of them being fixed by one extremity very obliquely to the inner lip of the ramus of the ischium from the tuberosity upwards. Thence, it accompanies the root of the corpus cavernosum all the way to the symphysis pubis, and is fixed by its other extremity in the corpora cavernosa near their union, where the fibres of both muscles meet and are reciprocally expanded over both corpora. They lie a little lower and more interiorly than the roots of the corpora cavernosa. Winslow has shown two other and accessory muscles fixed lower down and more interiorly in the ischium than the former, which they accompany all the way to the corpora cavernosa, and then leaving them, are inserted chiefly in the urethra near the bifurcation of the bulbo-cavernosus muscle. (*Tr. du Bas Vent.* n. 568, 570.)

138. The *Corpora Cavernosa* are two very subtle ligamentary tubes laterally united to each other through a great part of their length and closed at their extremities. The two anterior extremities are connected together, each being rounded like the end of the finger; the two posterior, are separated like the branches of the capital letter Y; after the separation, they gradually decrease in size and terminate in an oblique point. These divaricated and pointed extremities may be called the roots, and the rounded extremities, the heads. The corpora are almost cylindrical from their roots to their heads. The ligamentary substance of their walls is elastic, being composed of fine close fibres which are partly transverse and partly oblique. The cavity of these tubes is entirely occupied by a strong cellular or cavernous tissue, which seems to be nothing but a continuation of the substance of the tubes. These cells communicate with each other and are always more or less full of blood, resembling pretty much the cellular substance of the spleen,—but with this difference, that the walls of the cells are thicker in these cavernous bodies, and their cavities have no accessory tissue. By the union of the two corpora cavernosa externally, two grooves are formed, one above, the other below. The lower groove is somewhat broader than the upper, and is occupied in its entire length by a third tube, namely, the urethra. The roots of the corpora cavernosa are attached to the edge of the small ramus of the ischium and pubic bone. They meet towards the symphysis pubis, where each of them becomes a cylindrical tube, and unites with the other. The heads, or rounded extremities, come together at the base of the glans, which is an expansion of the urethra, and to which they are closely united. The lateral apposition of the corpora cavernosa from their roots to their heads, forms, by the union of their transverse fibres, a particular septum. Between the fibres of this septum are several small empty spaces, by which the corpora cavernosa communicate with each other; and therefore by blowing into one of them, the other also is inflated. Toward the rounded extremities, the septum becomes finer and diminishes. (*Tr. du Bas Vent.* n. 523–529.)

139. [*Vessels.*] The arteries come principally from the internal iliacs or hypogastrics, and some also from the external iliacs and the crural. The principal arteries are the internal and external pudic. The external pudic sends a branch to each side, which having passed out of the pelvis by the side of the sacrum, runs on the inside of the tuberosity of the ischium to the roots of the corpora cavernosa, along the inside of the [ischio-cavernosi or] erector muscles. They also send ramifications to the bulbous head of the urethra, to the corpora cavernosa and also to the scrotum. The internal pudic, having supplied the rectum and the bladder, send blood to the vesiculæ seminales and the prostates, and after communicating with the hemorrhoidal vessels, they pass under the arch of the pubic bones, and partly enter at once the corpora cavernosa, partly run along their upper side, sending off small lateral branches which embrace these bodies like irregular half-arches and penetrate them by numerous ramifications. The crural arteries send each likewise a considerable branch which is distributed to the integuments of the penis, under the name of the external pudic, and which communicates by lateral ramifications with those of the internal pudic. Communications exist, not only between the internal and external pudic of the same side, but also between the external of the one side and the internal of the other. The distribution of the veins is almost the same as that of the arteries. The principal vein is that which passes directly under the symphysis pubis between the two arteries and occupies the whole upper groove formed by the union of the corpora cavernosa. It is very large, often double, seldom triple; but the trunks do not separate while in the groove. It has a number of valves. This vein is formed by the union of the hypogastric branches, which, after passing on the two inner sides of the pelvis, meet about the middle of the arch of the pubic bones. At this place, we observe a venous plexus which covers the upper convexity of the first portion of the urethra, before it is surrounded by the spongy substance. (*Tr. du Bas Vent.* 576–581.)

140. The *Nerves* come from the lumbar and sacral nerves and communicate with the intercostal and the mesenteric plexuses. Near the arch of the pubic bone on each side, they form together a particular cord, which passes under that arch along the upper side of the neighboring corpus cavernosum at the side of the artery already mentioned [the external pudic].

In their passage over the corpora cavernosa, they send off a great many branches, which embrace the corpora in every direction. They run between the skin and the ligamentary integument, being so disposed that the arteries lie between them, and the great vein in the middle. There is likewise a nerve[1] on each side produced from the union of the second, third and fourth pairs of the sacral nerves, but principally from the third. It goes out of the pelvis above the ischio-sacral ligament, passes by the inside of the tuberosity and small branch of the ischium, and is distributed to the corpora cavernosa, to the muscles belonging thereto, and to the neighboring parts. (*Tr. du Bas Vent.* n. 585–588.)

141. Boerhaave. (*Instit. Med*). The corpora cavernosa, each invested with its own membrane, and mutually joined together by means of a middle septum, make up the main body of the penis. This whole body is then surrounded by a cellular membrane of remarkable structure which also surrounds the middle septum; then, by a firm nervous envelope, which sets bounds to its expansion; and lastly by the cutis and cuticle. The arteries are split up into innumerable capillary arteries, and are then continued into the little veins. In the latter, there are innumerable hollow cells communicating with each other and all discharging into the great vein which runs down as a single trunk along the dorsum of the penis under the ligament connecting the pubic bones, and which, near the prostates, finally divides into two branches that empty on both sides into the internal iliac veins. But the veins of the corpus cavernosum of the urethra[2] are placed beside the accelerator muscles. The muscles arising from the external tuberosity of the ischium below the origin of the corpora cavernosa, are inserted into the firm nervous envelope of these corpora, where, becoming tendinous, they disappear. With the swelling of the muscles, the beginnings of the corpora spongiosa[3] are more closely pressed against the tuberosities of the ischia, and their veins tightly closed; the body of the penis itself is more closely pressed to the pubic bones and their middle ligament; and the great vein of the penis is more compressed. And therefore the arteries and the vein become filled, and hence the great vein becomes still further compressed. Hence also the cellular sinuses become filled with blood. (n. 655–657.)

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[1] The nerve referred to is the pudic nerve; see Plate IX and *cf.* n. 35 and note.

[2] The corpus cavernosum of the urethra is commonly called the corpus spongiosum, to distinguish it from the two corpora cavernosa of the penis, between and underneath which it lies.

[3] That is, the corpora cavernosa, which are the corpora spongiosa of the penis as distinguished from the corpus spongiosum of the urethra.

142. Morgagni. (*Advers. Anat.*) When the corpora cavernosa of the penis are inflated, the corpus cavernosum of the urethra is not distended. The septum between the two corpora cavernosa should not be made a separate part as distinguished from the corpora themselves. (Index s. v. *Penis.*) On injecting an artery which enters the bulb of the urethra at its side, it was found that the whole of the spongy substance of the urethra was distended, and that not a single drop of the injection had permeated to the nervous corpora[1] of the penis; the injection came back through the vein that runs through the integuments of the penis. [When the penis was subsequently cut open, no part of the injection was found within the nervous corpora; but it was observed that] the nervous substance of these corpora was tinged with the color of the injection. (IV. § 5, p. 8–9.) The suspensory ligament of the penis, arising in the first place sometimes from the linea alba of the abdomen, but much more often from the middle of the pubic bone, sometimes higher up, sometimes a little lower down, and closely connected in front to the cartilage by which the pubic bones are bound together, is extended forwards as a firm and powerful membrane to the subjacent dorsum of the penis. It is by no means fixed into the septum of the penis, but unfolds into a firm tunic which, lying under the skin, invests nearly the entire penis and, moreover, the scrotum itself. Posteriorly, it is expanded over the dilator muscles of the urethra, while anteriorly, it forms, or, if you prefer, is continuous with what is termed the panniculus carnosus of the penis.[2] Finally, it passes down to the scrotum where it constitutes the dartos and the septum scroti. (I. § 18.)

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[1] i. e. the corpora carvernosa; cf. n. 146.

[2] The subcutaneous muscular tissue of the penis.

143. Schurig. (*Spermatologia.*) The penis is called the virga, colis, veretrum, etc. (III. § 1.) Cases of the penis being stiff in dead subjects. According to Ruysch, inasmuch as the penis is erected by air, which, introduced by means of a small tube inserted between the cutis and the cellular membrane (commonly called the dartos), inflates the scrotum, therefore the erection of the male organ so frequently observed in the bodies of persons killed in battle in the summer time and left lying on their backs, [must be ascribed to the fermenting of humors in the cellular membrane] (§ 10.) Cases of satyriasis and priapism. (§ 11.) Monstrous members; small members (§ 13, 17.) Shrinking and loss of the penis by poison; from birth; by gangrene; cancer; excision (§ 18, 20–22.) Entire absence of penis (§ 24.) Cases where the penis is crooked; double; bony; growing to the abdomen (§ 30–35.) Monstrosity of the glans (§ 38.) Wind escaping through the penis. Schenck shows that not only wind, but also the feces sometimes pass through the penis. Many cases of the passage of wind are cited from Thomas Bartholin (§ 41.) Imperforate glans (§ 46.)

144. Ruysch. (*Observationes Anatomicæ.*) If one of the larger and grosser nerveo-spongy bodies[1] be inflated, the veins running through the dorsum of the penis and whose branches also supply the nerveo-spongy bodies, are usually inflated at the same time. Ruysch asserts that the erection of the glans depends upon the orderly constitution of the arterial vessels. All the veins distributed through the penis, or if not all, at any rate all that I have met with, are perforated like a sieve with large pores and visible foramina; as is also to be seen in the splenic vein of the calf,—a fact not hitherto observed. This perforation of the veins gives the reason why the blood returning through the penis can be so rapidly emptied out, and the penis become flaccid in a moment. The spleen of the calf bears a considerable resemblance to the penis. The internal veins of the penis are extremely difficult to get sight of, and many anatomists deny their existence. Ruysch, however, has inflated these veins, but the substance of the internal vein, by reason of its porosity, is very easily confounded with the intrinsic and highly porous substance of the penis (*Obs.* 100).

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[1] "Larger and grosser nerveo-spongy bodies" was the name given by Ruysch to the corpora cavernosa to distinguish them from the corpus spongiosum, which latter he called the "smaller and finer nerveo-spongy body." *Cf.* n. 146.

INDUCTION.

145. *Every affection of the cerebral sensory, which is also called a passion,*[1] *induces a peculiar and corresponding state on the fibres of the whole body. This state is first induced on the internal sensories; and since the medullary fibres of the cerebrum and also the nervous fibres of the body, arise from these sensories, a similar state is induced on the fibres and consequently on the whole body which is woven organically of nothing but mere fibres.* On these points, see Transaction I.[2] They will also be dealt with in Transaction V [on the FIBRE[3]]. Such is the case with joy (*lætitia*), sorrow, anger, mercy, love of different genera and species, and other affections. *For joy expands, dilates and opens up the fibres, but sorrow and grief constrict them; anger hardens them and mercy softens. Venereal love above all other loves, is, as it were, a concentration and exaltation of all delightful affections,—that is to say, of joy, mercy, and many similar affections. And it not only expands the fibres, but also extends them, and brings them into a state most highly suitable for modification; in which state lies an effort to pour out all the essence, spirit, and life whatsoever, that they contain, and to transfuse it into as it were, a second self; and thus, by this path to transplant, as it were, all its own into another being, so that nothing that it possesses seems any longer to be its own. This is manifest from the exceeding violence of the love towards the beloved one; from the storge or parental affection towards infants; from the small value set upon life whilst this love occupies the sensories; likewise from the desire itself, its inmost delights before the act, and its supreme pleasure in the act.* These are points belonging to psychology. *As is the state of the fibre, such also is the state of the purest spirits*

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[1] Passion is here used in its root meaning derived from *patior*, to suffer. The cerebral sensory is *passive* to sensations, that is, is affected by them; hence results "affection, which is also called passion."

[2] See 1 E. A. K., 472, 503.

[3] See the FIBRE n. 274 *seq.*, and particularly n. 314–316,—"that the whole form of the body, internal and external, consists solely of fibre."

in the fibres, and such the state of the spirits in the blood, nay, wherever they reside. This is evident enough from the signs of love in the very eyes, as exhibited in their visible radiation, and from the inmost life of the several parts as well as of the blood itself. *This state, being superinduced upon the fibres, a similar state is induced on the whole system. But it gives forth no effect, except in the ultimates of the fibres, that is to say, in the organs that are formed agreeably to the giving forth of this effect. In these organs, therefore, is implanted the faculty of receiving these modes, of applying them to themselves, and of advancing them onwards even to the final effect which is the expulsion of the seed.*

146. *When, therefore, the several fibres are set in this state, and particularly those ultimate fibres that weave and construct the several organs of generation, then all the parts that are at hand,—fibres, simple, compound, motive, and tendinous; bloodvessels, and the membranes composed therefrom; septa; integuments, purer and grosser,—put on a similar state; that is to say, they all naturally expand and extend. In a word, the parts that are lying flaccid become erect and on the stretch.* This is the natural effect; for all the parts that are composed of fibres put on the state of their fibres; nor is there in the universal body a single part that is not organically woven or built up of fibres,—on which subject, see the Treatise on the FIBRE. *Therefore, the cells, both those of the corpora cavernosa of the penis, and those of the corpus cavernosum of the urethra and its glans, put off their state of relaxation, and become erect and tense; for, in agreement with ourlaw, they are both expanded and extended. So like wise the vessels, and especially the arterial vessels, which, on other grounds, are of such a nature, that when expanded, they are also extended.* See Trans. I [n. 228, 229]. *Thus, when the minutest arterial vessels in the corpora cavernosa are expanded and extended, that is to say, erected; and when at the same time, the like occurs to the larger vessels or trunks composed of similar fibres, then the blood flows in abundantly, strongly, and pronely, and fills up the minutest arterioles; these finish the work, and so manage, that when the several membranous septa of the cells are raised by their own force, they shall at last be finally excited by the arterial bloodvessels. For this reason, we attribute the erection of the penis to the blood,* *when yet this is only the last effect, and although, apart from the prior cause, the blood will, indeed, erect the member yet it does not always incite to coition from an internal cause.* Ruysch has delineated with great accuracy the mode in which the large artery traverses and ramifies through the corpora cavernosa [*Obs. Anat.*, Fig. 76]. It runs through the middle of the corpora cavernosa of the penis, and is so ramified over the several membranes of the cells that there is no part of a membrane that is not irrigated by the ramifications. Furthermore, into these same membranes flows an abundance of nervous fibre, and for this reason the ancient anatomists, and so also Ruysch, termed these corpora cavernosa, nervous and spongy bodies. It follows from this, that the animal spirit here contributes the main work; not by any means that it flows into the cells, but it flows into all those membranous walls that make up this spongy substance both in particular and in general. For the only effect is that all the cellular walls are erected by the aid of the spirits and the blood, that is to say, by aid of the fibres and arterial vessels. *When, therefore, the penis, both in particular and in general, is expanded and extended by the fibres and arterioles, all the avenues into the veins, and also the veins themselves, are tightly closed, to the intent that, in the meantime, the arterial blood alone may be kept shut up in its little channels. These veins are quite constricted and barred by the internal force, and particularly by the external; for they occupy the surface like great hives, and when the corpora cavernosa are extended both breadthwise and lengthwise, they are so compressed that the blood cannot escape into them.* The arteries are transmitted through the middle of the penis, while the veins are rejected toward the surface. A delineation of the great artery and its branches may be seen in Ruysch's Figure [76], and a delineation of the veins in Heister's [Table V. Fig. 22, 23].[1] From the latter delineation, it appears that the veins which occupy the surface cannot fail to be compressed on every side when the member becomes swollen. Injection proves the same thing; for when the arteries are injected and the member becomes swollen, not a drop of arterial blood escapes into the veins. Reason likewise dictates the same thing; for were there a free circulation, the arterial blood would not tarry on the spot, and therefore could yield no result. Moreover, to say that both the arteries and veins, and also the cells and follicles could be filled and distended with blood at one and the same time, contravenes experience. There are also several lesser veins, which lie imbedded in the cellular structure of the penis. The mode in which these are constricted has not as yet been discovered by anatomy; but, from the greater, a conclusion may be drawn with regard to the less, or from the general in regard to the parts; namely, that between them there is a likeness and parallelism.

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[1] Ruysch's figure shows a penis that has been injected, and after drying, has been dissected longitudinally. A large artery is seen running through the middle of the corpus cavernosum on the inner surface of the bisected half, and giving off innumerable ramifications. Heister's figures represent a penis that has been injected with mercury, in a remarkably successful manner. They show the external, superior, and inferior surfaces of the cavernous bodies,

147. *The penis may also be expanded and extended, that is, erected, artificially, or by injections; that it is to say, by injecting water, other liquid, spirits, wax, mercury, or air into the veins and cellular substance of the corpora cavernosa and for a brief space preventing its exit. This cause of erection is purely artificial, and not natural, for anything that expands the cells and their walls, both lengthwise and breadthwise, will cause the member to tumify.* In the natural way, all the membranes of the corpora cavernosa, both particular and general, are erected by the force of the spirits in the fibres, and of the blood in the arterial threads. If these cells are erected by the impletion of the cavities, the same effect will follow, but such effect is only artificial.

148. *From the foregoing considerations, it is apparent that the muscular fibre contributes nothing to the erection of the penis; for erection exists from mere desire quite antecedent to the action of any muscle, whether belonging to the penis or to the urethra,—which muscles were called by the old anatomists Erectors and Accelerators, respectively.* For the penis is excited and stiffens from mere thought, and from mere sight and touch, before

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with the numerous ramifications of the veins; the glans is shown as consisting of such minute and innumerable convolutions of blood-vessels as to appear to be nothing but a vascular body.

any muscle is in play. *But the muscular fibre and the aponeurotic membrane, both of this fibre and of the suspensory ligament, and also the extension of this membrane, contribute nothing more than reaction against the action of the fibres and arteries proper to the penis and urethra; and this to the end that there may be due and corresponding reaction and action and thereby the limitation of the expansion and extension; and moreover, that in the heat itself, that is, in the venereal act, it may superadd to the active force, a force that is more strongly reactive; so that not only the seminal humor may be pressed out from the vesiculæ, but also its auxiliary and companion humor from the prostates, and from the glands and arterial conglomerations of the urethra.* As was indicated above [n. 110]. For without a reactive muscular force, or the motive fibre which is the grossest of all, the expansion, extension, and action could not be limited. This motive fibre, since it consists of mere nervous fibres and arterial capillaries, is also extended at the same time; but still the muscle which governs it presides over the whole of that fibre, to the end that it may suffer itself to be extended and expanded more or less. This is the reason why its fibres extend over the whole penis; likewise also the suspensory ligament to which the fibres on all sides are finally attached; they draw their force from the muscle. Tendinous fibre of the sort is not usually attached elsewhere than to the extremities, which it is wont to tighten and relax; thus, by one extremity to the bones of the ischium and pubes, and by the other around the whole penis. Were it not for such limitation, the penis would swell beyond what it could afford, for there would be nothing to resist. The utmost force of action on the part of the muscles exists in the act itself. For the juices are then to be squeezed out of their organs; the excretory ducts resist them, and therefore, in order that reaction may then overcome action, it is requisite that the muscular fibre at this time dominate over the nervous and arterial fibres, and at that instant all is set free, or explosion occurs. But this does not occur naturally before the act, for until then, the active and the passive forces are equal. But thus much in general; it will now be well to consider particulars. Without a general idea, however, ideas of singulars would not easily be perceived, for singulars must attach their idea to some general. Such is the lot of human intelligence.

149. *But it is not sufficient to point out the causes; the means that concur must also be shown, and the mode in which they progress. For nature must everywhere proceed from inmost things to outmost. If she proceeds from the outmosts to the interior and inmosts, order is perverted; for there are degrees, and as it were, a ladder by which nature descends and ascends. Throughout the descent, causes* a posteriori *must concur with causes* a priori, *and both make up one series. This series it is which has now to be unfolded, otherwise we shall perceive nothing distinctly.* These subjects are dealt with in our Doctrine of Order.[1] When nature proceeds from inmost things to outmost in substances, she does the same in modes and other accidents; but all things are so ordinated, that there is always some peculiar cause of the order that follows, whereby it is excited into action. *The* INMOST CAUSE *excites the simple fibres. This is none other than the final cause, that is to say, it regards the procreation of offspring for the sake of society on earth and in heaven. This cause is implanted in the nature of the soul. Thus, since the soul, residing in inmosts and acting from itself, regards nothing but end, and the effect itself as an end, therefore the first exciting cause of venereal love is the procreation of one's kind. Since this cause lies within the purest essence, it there acts from itself, and sets in motion the very simplest fibres of all.* In regard to the simple fibre, the reader will see marvels in the treatise On the Fibre.[2] The simplest fibre is not that which passes visibly from the medullary part of the brain into the nerves, but myriads of simple fibres compose one such medullary fibre. Their mode of action will be shown in Transaction V [On the Fibre]. This cause lies deeper, that is, it issues from the nature of the soul itself. *The* SECOND EXCITING CAUSE *is that which sets in motion the fibres compounded of simple fibres, that is to say, which excites the animal spirit. This fibre, or this animal spirit, is not excited to action by the same cause that excites the simple fibres, except as it were remotely; for this cause does not flow into the compound fibre otherwise than as a faculty or conatus flowing into the things beneath. And therefore, in order for the*

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[1] See n. 131, note.

[2] See the FIBRE n. 274–297.

excitation of the fibre or animal spirit, a cause of its own is required, which afterwards breaks forth into act as though from an antecedent conatus. Of these exciting causes, the internal are thoughts concerning venery and its objects, and imaginations thereof; and the external are the seeing of such objects, conversations, and more ultimately, kisses, touch, etc. All these causes excite a desire which deserves to be called not rational, but merely natural, being almost common to men with brute animals. This second cause is what properly rouses up the animal spirit and compound fibre to lust or desire; the effect whereof, as I have already intimated, is a modification of the spirits and the compound fibres, which are brought simultaneously into a state of expansion and extension. *The* THIRD CAUSE *is the external contact, and particularly the embrace and contact of the glans penis itself, furnished as it is with so many sensitive papillæ from the corona to the head and frenum, where the papillæ are concentrated and where the sensation itself, as it were, converges. This exciting cause is the third in order, and stirs up the blood itself to concurrence with the prior causes.* Thus nature progresses from inmosts to outmosts, that is to say, from the soul itself to the blood, which is, as it were, the soul of the body; for the blood is the soul's vice-gerent in the body, or in ultimates. *The* LAST EXCITING CAUSE *of venery or desire, or rather of lust, consists in whatever excites the motive fibres or muscles. For the muscular fibre is composed of genuine fibre and of arteries, and hence the cause that excites it comes into play still later. This cause is excited by the succussion and agitation of the muscles of the penis, urethra, loins, abdomen, and pelvis, that is, of the pubic bones and the ischia, whereby the extreme degree of excitement is aroused.* This is a fact known to every one. That the muscular fibres are excited by this cause will be shown presently.

150. *In order, therefore, that the first desire or first love which is genuine and which exists solely with a view to the propagation of offspring, may break forth into the act, it is necessary that all the causes concur, and this in due order from the first cause to the last, whereby a series of causes is produced in which the inmost cause lies as the beginning and soul of the rest.* This is evident, since it is a matter of our reason itself; nor do I know that any-one can entertain any doubt respecting this series. All these causes likewise concur, in order namely, that in the venereal act they may constitute one entire series. The first cause, which is the origin of all, is not denied; [nor] the second, namely, sight, embraces, the whole touch, and the several things that occur and at once insinuate themselves into the imagination; [nor] the third, in the act itself, when the glans furnished with papillæ feels the irritation of the objects that it meets; [nor] the fourth, arising from the agitation of the body and the divers agitations of the muscles. If one cause in this series is wanting, there is no natural progression. *This series does not always consist of four degrees or terms. There is also a series, which consists only of three, and which begins from sight and imagination. From this series comes concupiscence, which does not belong to the soul itself, but which yet proceeds to the ultimate in a like progression. Nay, there is a series which consists of only two terms, or which begins from the rubbing and pinching of the glans. In this case, however, the prior term, that is, imagination, must be added before the effect takes place; but this is the inverse of the order of nature.* For it takes its beginning from the posterior cause and rises to the prior. In one way, it may be called natural, namely, that in all that we do, we begin *a posteriori*, and our order seems to be so instituted that we proceed from the posterior to things prior, before proceeding from the prior to things posterior. But since this is contrary to the order of nature, it by no means conduces to the weal of life, but on the contrary is hurtful; see above [n. 95].

151. *But it is not sufficient to know the causes, it is also necessary that we know the influx of the causes into the genital organs. The* First Cause *flows in a general manner into all the simple fibres of the whole body, and expands and extends them; it also modifies the purest animal essence, to the end that this essence may be in the state of pouring out its entire self. This effect is possible only in the ultimate organs, that is, in the testicles, which are formed expressly for this use; for the above essence is not discharged anywhere else, unless perhaps into the compound fibres or into the animal spirit and from thence, at last, into the blood.* That the fibres of the testicles are simple fibres, or that the fabric of the testicles is so constructed that the simple fibres terminate therein, and emit the purest essence, may be seen in the Chapter on the Testicles [n. 42–44]. The fibres likewise terminate in the epididymides and vasa deferentia; but here is the last bound of this same cause,—for every cause has its maximum and its minimum,—and in the epididymides and vasa deferentia this purest essence has already grown up into the first essence of its seed. *The* SECOND DEGREE, *considered in itself, does not act immediately upon the testicles and epididymides, but upon the vesiculæ seminales; for it expands and extends the fibres of these vesiculæ, and also modifies them, enabling them to act in a suitable manner on the fecund seed itself, that is, on the seed of the first degree. Thus, given the intrinsic motion of the primitive parts of the seed and the modificatory motion of the fibres of the second order, the effect follows as a consequence.* But on these subjects, see the chapter on the Vesiculæ Seminales [see particularly n. 95]. *The* THIRD DEGREE, *considered in itself, acts upon the prostates and upon the bulb and all the glands of the urethra, and also upon all the walls of the cells of the cavernous bodies, both of the penis and urethra, expanding and constricting them,—and this by a still more evident modification. It acts likewise, on the fibrous and muscular tunics of the arteries, enabling the blood to run into the now erected septa and to complete the work thus far advanced.* That this degree expands, extends, and modifies, not only the compound fibres, but also their groupings and tunics, is well enough known from the effect; for these septa are comparatively gross, and the corpora cavernosa consist of nothing but septa of the kind. The finer then the cellular or spongy substance, the swifter and surer the effect. And therefore, when the cause progresses from the prior to things posterior, the cavernous tissue of the surface is what is first erected by the prior; and then the inner cavernous tissue which is more coarsely cellular. But if on the other hand, the cause proceeds from what is posterior, then the inner cellular texture is erected before the outer. First of all, if we progress in order, the erection takes place in the spongy substance of the urethra, which is closer and finer than the other sponges; for it progresses through the nerves and the arterial vessels, and the nerves proceed from the side of the arteries and insinuate themselves into the several septa, and also follow the artery and its branches. *Nerves cannot be wanting which shall enter all the membranes, both general and particular. Nor can arteries be wanting which shall irrigate the several septa; for they traverse the middle of the corpora cavernosa, and a way is open for them to enter in from many sources.* The nerves come principally from the sacrum, since they are nerves of the cerebellum; likewise from the intercostal and par vagum, or from the mesenteric plexuses, of which the pelvic plexus is formed. The arteries are from the iliacs, that is, from the internal and external hypogastrics, from which at this time a free influx is allowed. *The* FOURTH DEGREE *excites the muscular fibres, that is to say, the fibres of the muscles belonging to the penis and urethra, and of the abdominal and all the lumbar muscles; and also the suspensory ligament, which, together with almost tendinous muscular fibres, is extended over the body of the penis, and, individually, over all the organs which precede the penis, such as the prostate and the bulb, and distinctly into the spongy septa. The muscular fibres thus excited, so compress these parts by alternate actions, that with the overcoming of the reagent force, they powerfully ejaculate the contents with which they are loaded.* With regard to the muscles. Those called the erectors[1] are proper to the penis, and extend over the whole member in general, while the accelerators[2] extend over the bulb and from thence on every side into all the cavernous substance of the urethra and penis; so that what the erectors effect [upon the penis] in general, the accelerators effect upon the septa of all the little parts [thereof] in particular. These muscles surrounding the prostate and the bulb, urge on and explode with extreme force the whole contents of these organs. Thus the motive fibres of the penis urge on and explode all the juice which is discharged immediately into the urethra. The suspensory ligament, which goes over the tunic and constitutes its tendinous portion all the way to the corona of the glans, and which is continued almost from the linea alba of the abdomen, and also over the dartos and to the septum of the scrotum, acts in like manner. This tunic being tendinous, must necessarily be reactive; but it is a general reactive, while the motive fibres of the above mentioned muscles enter into the septa particularly. Respecting the suspensory ligament, see Morgagni [n. 142]. *Moreover, the great ischiatic or crural nerve, which goes to the muscles of the loins, is now in its utmost effort; and on the action of this nerve, and consequently on its natural situation in the action, depends the very effect, not only as regards the work, but also as regards the body.* For all the muscles of the loins depend upon the great ischiatic nerve, which is the largest of the nervous trunks. [From the sacral plexus] there is also a branch going to the penis and vesiculæ seminales, which runs through this nerve; see Winslow [n. 140]. Since this nerve is the largest nerve [of the body] and is actuated according to every natural motion of the body in the act of coition, it follows that we ought to be in the natural position when that work is being carried on. Otherwise, as when in the erect position, the nerve greatly labors and is distressed, whence results the effect of lassitude and debility in the muscles of the loins and feet; for at this time they are deprived of all their juice.

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[1] The ischio-cavernosi, see n. 137.

[2] The bulbo-cavernosi, n. 116, note.

152. *There are two spongy or cavernous substances, the one proper to the urethra and the other proper to the penis. These two are distinct, there being no communication between them. The spongy substance of the urethra, namely, that which constitutes the surface of the glans, is what is first excited by the causes of venery, and when this is excited, there is an influx of arterial blood into the spongy substance of the penis.* It has been found by injection and inflation, that the glandular substance of the urethra is distinct from that of the penis, and that the substance of the urethra is copiously poured out into the glans. In venery, the cavernous substance of the urethra is what is first erected, for to this substance is prefixed the prostate, the vesiculæ seminales, and the bulb.

153. *In the affection of venery, the order of erection seems to be as follows: First, the spongy substance of the urethra and glans; next, and almost simultaneously, the superficial spongy substance of the penis which is of a finer texture; and lastly the spongy substance that occupies the center, and is coarser in kind. But a different and almost contrary order is set up when the penis is erected, not by the prior cause of venery, but by some posterior* *cause. In this case, the grosser part of the penis is what is first excited; next its finer or superficial part; and lastly the spongy substance of the urethra. In the erection of the penis apart from the penis,*[1]*—as in the time of repose, in the night, in lying on the back,—nothing but the substance of the penis is erected, and only slightly the substance of the urethra, which still remains somewhat flaccid, although by reason of the expansion and extension of the penis, it emulates a similar mode.* This follows and is clearly evident, not only from an examination of the effect, but also from the connection of the causes. For the substance of the urethra is erected immediately by the state of the vesiculæ, the prostate and also of the bulb, and therefore by the influent seed itself. This substance is, moreover, of a finer texture, so that the state of erection of the cells is a necessary consequence. When these are erected or expanded there is then an influx of the blood into the spongy substance of the penis, whose superficial substance, or that next the tendinous or aponeurotic tunic, and which is purer, is erected; and since this is continuous with the second or middle substance, it prepares the latter for letting the blood run in. For the blood does not flow into the walls unless preparation has been made by the extension of the fibres. But if, on the other hand, it is not love, but some other cause[2] that extends the penis, it is a sign that this is brought about by the blood alone, and by the loosening of the fibres of the cerebellum from the fibres of the cerebrum. This may also be a matter of experience to any one who so wishes. Thus the erection of the penis in sleep, apart from dreams or the imagination of venery, is spurious and purely carnal; but the other kind of erection is genuine. The former does not produce the latter until the latter is also excited by its own causes; it is a mere inflammation, as may indeed be observed by feeling the glans and urethra, which continue flaccid, notwithstanding the stiffness of the corpora cavernosa of the penis. *There is also another kind of spurious erection, in which the veins and the cellular cavities alone are filled with blood.* This is sometimes the case after coition and is recognizable by the weight of the organ.

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[1] That is, in the erection of the corpora cavernosa without the erection of the corpus spongiosum.

[2] *At vero, si causa amoris seu alia extendit*, etc. (But if love or some other cause extends, etc.). The sense of the passage, however, indicates some slip or misreading here; we therefore suggest the emendation on which the translation is based, namely: *At vero si* [non] *causa amoris* [sed] *alia extendit*, etc.

154. *As soon as the venereal heat has cooled down, the inmost parts grow flaccid, and then successively, the middle and outmost. For the blood does not then run back through the artery, but unloads itself abundantly into the inner and lesser veins, and afterwards into the larger veins and even into the venous channel; which veins are severally relaxed in the same successive order; and finally it escapes from the arteries into that solitary vein, which lies near the pubic bone. In this way the blood passes out, and little by little, the penis collapses.* The tension of the cells is what causes the communication between the arteries and veins to be suspended; hence, as soon as the cause of erection ceases, the communication is reopened. The veins moreover, are provided with valves to prevent the blood from flowing back. But in proportion as the penis is unstretched and relaxed, so the great dorsal vein, which is sometimes double or triple, is opened; the blood which it carries is received into a more copious channel outside the penis, and then, splitting into two streams, it flows back into the iliac veins. For such is the organization at this time, that there is a free communication between streams where previously, both in general and in every particular, communication was everywhere precluded. *In order that the blood of the spongy substance of the urethra and glans may not rush out precipitately, but that it may escape only slowly; in order also, that, during the act, the vein may be strictly closed, it has to run down the upper membranous portion of the urethra near the pubic bone by remarkable flexures,—a fact which makes it sufficiently apparent that when that part of the urethra is extended, no portion of the blood can possibly get out.* The anastomoses of these veins is termed by Santorinus the Labyrinth [n. 118]. This labyrinth is so placed and flexed that the blood cannot possibly run out during the act; for it is superficial in position, and with the expansion of the urethra, it, as it were, disappears.

155. *That nothing may resist the impetus of the returning blood, especially while a means of exit is still open outside the body of the penis or urethra, a passage is also afforded from the* *veins into the cavities of the cells and from these back again into the veins; for the walls of the veins, like those of the splenic veins, are perforated by innumerable orifices.* As there is an influx and reflux, so the first out-pourings from the veins appear to be into the cells,—and this in order that the penis may be still kept a little expanded, and that the blood may not rush out precipitately and, over-distending the vessels, render them after a few acts of coition, unfit for resistance. For the penis is as much erected by the blood in the veins and cells as by the blood in the arteries,—as shown by inflation and injections. See Heister's figure of the erected penis;[1] as to the fact that the veins are pierced by foramina, consult Ruysch [n. 144], and other anatomists. The cells also appear on dissection to be more or less loaded with a supply of blood, see Winslow [n. 138]; but this red blood is forced into the veins as the cells are relaxed, or as the walls are approximated to each other. That they can be closely approximated, is plain enough from the condition of the penis in its state of relaxation; thus in some persons, particularly the decrepit, the penis is so far drawn back into the scrotum, that it seems to have disappeared. In order then that but little room may be afforded during relaxation, the blood is expressed from the cells back again into the veins. The cells also communicate with each other, as likewise do the corpora cavernosa of the penis; and this, in order that no drop of blood may be anywhere held back from flowing through some perforation into a vein. Without such communication between the cells, scirrhosities[2] and obstructions of the cells might very easily arise.

156. *That the cellular spaces of the corpora cavernosa may be perpetually irrigated by a certain humor, and thus be kept in a state for performing their function, an abundant liquid is drawn and expressed into the cells through the cellular tissue from the scrotum; and this for the further reason, that the venous blood running into these cells may be diluted, to prevent its coagulation. For the cellular tissue around the scrotum is continued on into the cellular membrane of the penis, and, by the prepuce, all the*

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[1] See n. 146, note.

[2] Scirrhosity or scirrhous, from a Greek word signifying hardening or induration, is a disease distinguished by the hardening of glandular tissue.

way to the circle or corona, where it is reflected in the form of a fine cellular substance, and thence passes by continuity into all the cells. Wherever there is any cavity that is expanded and constricted, suitable irrigating humor is always at hand. Such is the case in the abdomen, thorax, pericardium, brain, and elsewhere, and such also is the case in the smallest parts; for the presence of this humor preserves the power of expansion. In order then that these cells may have no lack in their proper humor, all the humor that surrounds the cellular texture of the scrotum, of which we have treated above [n. 64], is continued to the penis. But it does not flow in except by winding passages,—passages which are traversed before it has reached the duplicature; so that it would appear rather to be squeezed out thither, than to flow in spontaneously; for the tendinous or aponeurotic tunic prevents it from passing elsewhere. But as to whether any portion of it runs also into the spongy tissue of the urethra and glans,—this we may indeed surmise to be the case, but it would occur only around the frenum where the prepuce is attached; although the cells of this substance are sufficiently irrigated by arteries of their own, whence comes that humor which is excreted into the urethra. It remains still to be observed whether or not it is this humor of the scrotum that also passes into the urethra, the scrotal humor thus directing its streams around the urethra, and thus around the seed, in like manner as the humor of the testicles is directed through the urethra.

157. *If our judgment is to be based on the constant rule of nature, we may then conclude, that as the seed rushing out from the testicles keeps the central axis of the urethra, so the humor of the scrotum keeps the surface; to the end that the two humors may be again concentrated by their beginnings, and again become concurrent. That there is such a connection may also be confirmed from the external appearance; that is to say, from the fact that there is a certain line running down from the orifice of the urethra and from the frenum, through the whole lower portion of the tunic of the penis and through the lower portion of the scrotum, and finally through the perineum to the anus; and that there is a similar communication through the septum of the scrotum. Moreover, also, from the fact that the expansion of the penis so com-*

presses the spongy substance of the urethra and glans, that it contributes to the expression of this humor. But all these subjects require further investigation, since our conclusion is made from the connection of the parts, without the confirmation of experience; but the investigation is an easy matter. Still the compression of the spongy substance of the urethra is evident from the situation of the corpora cavernosa and of that part of the glans [which is in contact with the corpora]; see Ruysch's plates.[1]

158. *From the above, we may now deduce the cause of the varieties that obtain in regard to the greater or less rigidity or flaccidity of the penis. The cause of the rigescence or stiffening is, in the main, the abundant supply of spirits; and not only are the walls of the cells erected by the abundance, but they are also excited to erection by the motion of these spirits, particularly of the spirits in the vesiculæ seminales; and this, naturally when there is a superfluity, see above,* [n. 91–93]. *A cause of rigescence also exists, when the arterial, fluid, and spirituous blood so abounds that it can penetrate into the minutest capillaries, and yet the machine be held so whole and entire, that all efflux into the veins, both the particular veins and the general, is obstructed. Thus the penis is easily erected by causes both internal and external; but with constantly greater difficulty, in the degree that these causes are wanting or are destroyed. For the member grows flaccid from poverty of spirits; from poverty of spirituous blood; from the obliteration of the minute capillaries in the cellular substance; from the coalition of a number of these capillaries into one larger vessel; likewise from the coalition of the fibres, whence arises a species of tendinification; from the induration and condensation of the general and particular membranes of the septa, whereby their reaction is lost, and there is no reaction corresponding to the action, in which case, from the very beginning of the act, they resist erection; from the ready escape of the arterial blood into the veins and from the veins into vessels outside the corpora cavernosa; from failure of desire, namely, when the sharpness of all the sensations and likewise of the imagination,*

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[1] The plates referred to (Obs: Anat., fig. 78–80), exhibit a cross-section of the glans in the region of the corona, showing the decreased bulk of the corpora cavernosa.

perishes. The causes of this are many in number namely, age, excessive use and the consequent rupture of the connections, and also, from the same cause, a dulled sensation both internal and external; it arises also from the state of the blood, thus from diseases and other contingent causes; from poisons; from congenital defect; moreover, also from conflicting passions of the animus, such as anger and sorrow, for the former hardens the fibres, while the latter contracts them; from the congenital state of the penis itself; not to mention many other causes. For in proportion as the interior causes are deficient, the external causes require to be more readily excited. In proportion then to the impotence of the virile member arising from any of these causes, in the same proportion that member contracts, diminishes, shrinks into the scrotum, and conceals itself from view.

159. *Satyriasis or priapism rarely exists from internal causes, but more frequently from external, as is recognizable from the burning desire which is then felt. For satyriasis consists of a kind of obstruction and inflammation, which prevents the arterial blood from escaping into the veins; hence comes rigescence. Rigescence likewise arises from the sanguineous obstruction of the veins and cells; this constitutes another kind of satyriasis. It is recognized by a number of symptoms, but particularly by the state of the glans continued from the urethra; also by a certain spasm of the cells, which cannot regain their pristine situation; and also by the muscles,—not, however by their rigescence, but by their flaccidity, their fibres being relaxed and unable sufficiently to react; likewise by the pressure of the parts of the anus, whence come the arteries and veins.*[1] *The erection of the penis after death arises from similar causes, and especially from the swelling up of the veins and cells, and the hindrance to the return of the blood therefrom, which happens while the corpse lies on its back; for after death, the arterial blood is precipitated into the veins.*

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[1] *A pressione partium ani, unde arteriæ et venæ.* The reference is probably to the parts *in the neighborhood of* the anus, the pressure of which would affect the internal pudic artery and vein, which become the dorsal vessels of the penis.

CHAPTER IX

The Male Seed.

160. Boerhaave. (*Instit. Med.*) No humor is generated so slowly as the seed, or retarded by so many passages, or so much digested by rest.—The humor found in the middle of the testis, epididymis, ejaculatory duct, and vesiculæ seminales, when examined in the fresh state a little diluted with tepid water, and through a fine microscope, is seen to consist of innumerable, minute, longish, tailed, and lively little eels swimming in the liquid part of the humor.[1] This is true in man, quadruped, bird, fish, amphibian, and insect; but only in this situation. If these little eels be compared with the mass, figure, situation, and permutation of the carina of the chick as described by Malpighi, and with nature's law as observed in the generation of frogs, it will occur as probable, that these animalcules of the male seed contain the rudiments of the future human body; especially in view of the fact that when the testes, or this humor, are lacking, there is always barrenness on the part of the male.—The humor of the prostate does not contain any of these animalcules.—The seed, entirely different in nature from animal spirits, from volatile oily salt, from hot humor, and from ferment, is a bland, viscid, inert humor. (n. 650, 651, 653, 658.)

161. Leeuwenhoek. I opened several gnats, and discovered in their male seed, with the utmost distinctness, a large number of animalcules, which, however, were much smaller than those seen in the seed of the flea.—I remember having formerly sent[2] specimens, which I described as striæ, or fibres, and which were lying without any regularity entangled one with the other in the male seed. This description, however, I now entirely reject, since in the male seed of quadrupeds, birds, fishes, and even of insects, I now find animalcules (*Arcana Naturæ*, Ludg., 1695, p. 29–30; 1722, p. 22, 27). The male seeds of fishes are as large in the smallest as in the larger fishes of the same species.—In a minute drop of the seed of a ram, Leeuwenhoek found an incredible number of animalcules (*Epistolæ Physiologicæ*, Delft, 1719, Index, s. v. *Semen*). Incomprehensible is the number of animalcules observed in the same seed; therein are animals that are adult, and others that are not adult. They go one after the other in a long series (*Arc. Nat.*, p. 30). A large sized codfish easily emitted in the space of a month as much seed as would fill a hat (*Epist. Physiol.*, p. 282.) Leeuwenhoek saw animalcules in the epididymides (*Arc. Nat.*, Ludg., 1696, De Vivis Animalculis etc., p. 5). He also delineates seeds like little eels (*Opera*, passim). That this was the case he observed even more clearly in the seed of frogs, since the first shape of frogs is vermicular.—For every female ovule the male frog emits perhaps ten thousand of such animalcules, which are contained in his seed.—In the ovum of a flea, nothing was to be seen but globules swimming in a watery matter; [when Leeuwenhoek cut this ovum out of the mother] it became first a worm, and finally an aurelia or chrysallis (*Arc. Nat.*, 1696, De Generatione Ranarum, p. 51, 52, 53). In the vas deferens of a dog, there were also animalcules.—In a little particle of the matter or substance taken from the vas deferens of a cock, and no bigger in size than a grain of sand, Leeuwenhoek observed more than fifty thousand animalcules resembling freshwater eels. In many places they were so thickly and firmly conglomerated as to form a kind of opaque body; but in a little while, they again separated from the dense mass.—In the epididymides likewise, he saw a large number of living animalcules, under which, however, was seen a substratum of numerous and exceedingly fine globules, and also of many plano-oval bodies, the circumferences whereof were almost equal in size to globules of human blood; to which globules also life may be attributed, and this by reason of their active motions. [He thinks these motions are caused by the animalcules]. (*Ibid.* De Viv. Anim., p. 3. 5, 6.)

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[1] See Plate V, fig. 2.

[2] To Henry Oldenburg, Secretary of the Royal Society of London, of which Leeuwenhoek was a member and to which most of his epistles were addressed.

162. SCHURIG. (*Spermatologia.*) An anatomist named John Christopher Lang has written concerning these little worms [in opposition to Leeuwenhoek, whose opinion, he observes, supported as it is by much ocular evidence and illustrated by the elegant example of the generation of frogs, might easily deceive the incautious reader. Since, however, few have been so fortunate as to see these stupendous phenomena with their own eyes, the paradoxical observations of this single author could hardly receive general assent]. But now that other makers have constructed equally fine microscopes [especially those fine ones made by the clever Englishman John Mallet], it is evident to the sight that Leeuwenhoek was signally deceived by a preconceived opinion. For that which he takes for tailed worms in such great number, is nothing else than the active portion of the seed agitated within the viscid molecules, until, being very gradually consumed, there is left a residue of certain motionless fibrils, which this author parades as the carcases of worms. (IV. 65.)[1]

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[1] For further quotations from Schurig, see Appendix, n. 11, 12.

INDUCTION.

163. *To understand the nature of the seed, we must have a deep understanding of the nature of the soul, animal spirit, and blood, since the seed arises evidently and distinctly from them all. For the seed is the extract and complement of them all, or a certain quintessence which lies most deeply within them. Whatever we term simple, and whatever is the first principle of things compound, this must pass unclothed and naked into the parts of the seed, in order that the latter may be a substance wherefrom nature can begin anew and live anew. To enable us to form some idea of what the seed is, we must premise certain universals concerning the soul, the animal spirit, and the blood; without which we shall certainly be hallucinated, and shall seem to be enlightened by an intellectual light that is fatuous, and concerning things unseen, and, as it were, in a dream.*

164. *As respects the soul, there is no doubt that it is a substance, and indeed the simplest, first, inmost, and highest of all the substances of its body; consequently the ens of all those perfections, of which we form some idea as existing below the soul in material entities. This substance therefore it is, which the other substances in the animate body regard and look up to as the prince to whom they are subject. Nor is there any doubt, but that the soul, since it is a substance, is also a real essence, and consequently a form, which from its excellence deserves to be called a celestial and also a spiritual form.* What the celestial form is, and what the spiritual, will be seen in the Doctrine of Forms.[1] Nothing is more ancient or more frequent with theologians and philosophers than to term souls, and even angels, essences and forms.[2] But it is not enough to call the soul a spirit and to abstract from spirit all material qualities; these most certainly must be abstracted, but it still remains to be told *how* they are to be abstracted,—a matter which will come to be explained in the Doctrine of Forms.[1] Otherwise, if we merely abstract and do not demonstrate the abstractions, we fall headlong into darkness of the densest kind, so that we are entirely ignorant as to whether the spirit is anything or nothing, inasmuch as nothing is adequate to it, which our senses show us to be anything. *If the soul be an essence, it follows that a nature, power, and force lie within it; and if a force, then something that is analogous with activity and modification, or with action and mode, and if with action and mode, also with other accidents and qualities, of which we are able to procure an idea only from things material. But still nothing definite is said; for substance, essence, form, nature, power, force, mode, accidents, and qualities, are words and mere terms, which have nothing in them, unless we have procured a distinct idea of singulars by means of singulars, and thus by means of comparison with those things which we know for certain to be in the soul, and which require to be comprehended by thought alone, abstractly from words, although they must be expressed by words.*

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[1] See the FIBRE, Chap. XVI, which is a special treatise on this doctrine. The celestial form is there defined as the "perpetuo-vortical" (n. 266), and the spiritual as the "perpetuo-celestial, which is the most remote from ultimate or earthly form" (n. 267).

[2] See 2 E. A. K., 356, where a number of the Church fathers and of theologians are cited in this connection.

165. *Next comes the animal spirit, which is the medium uniting the soul and the body, that is to say, which is a substance, essence, form, power, force, mediate between the soul and the body; and which, therefore, is participant of both, and must draw all that is its own from the soul and at the same time from the purest elements or elementary substances which belong properly to purer nature or to the world.* In this way it acts as a medium; but the place of its action will be shown when we come to treat of the animal spirit.[2] First, however, we must treat of the fibres which carry that spirit; and must also form some idea respecting what are called the first elements of nature. Everyone, therefore, can imagine for himself the magnitude of the work required to disentangle one such substance and draw it out of darkness. But, we will make the effort.

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[1] See the FIBRE, n. 271—273; see also n. 317—318, and RATIONAL PSYCHOLOGY n. 4—9.

[2] See n. 10, note, and consult the treatise on the ANIMAL SPIRIT (in Post. Tracts), Chap. VII-IX.

166. *Lastly, comes the blood, which partakes of the animal spirit and at the same time of the elements of nature's lower degree, that is to say, of the principles of sulphureous and saline substances. Thus, by means of the animal spirit, it partakes of the soul; and in this way, the blood is the soul's vicegerent in the body, that is, in the ultimate things of the animal world; so that, in a certain sense, it may be called the corporeal soul.* But, we have already treated of the blood in Transaction I.

167. *The determinations of the first substance, essence, or soul, are called simple fibres, for these are the determinants and progenitors of all the other substances. The determinations of the animal spirit, to be self-represented as compounds of the simple fibres, are, properly speaking, the medullary fibres of the brain and the nervous fibres of the body. The determinations of the blood, are the fibres again compounded, that is, the arterial and venous vessels. Of these and of the fibres, properly so called, is compounded the motive fibre, which is the last of the fibres considered as determinants.* The reader will see these subjects unfolded in [Transaction V] Introduction to Rational Psychology, where I shall endeavor to set forth distinctly the doctrine of forms, of order and degrees, of representations and modifications, and to treat also of the several kinds of fibres.[1]

168. *And since it is of importance, that we comprehend what the seed is, and how the soul of the offspring is produced and brought over from the soul of the parent, it is necessary that I use terms of this kind which are familiar, and which give a comprehensible idea of the things to be presented; though I am not unaware that in a strict sense, such terms by no means square with those qualities which are and must be predicated as proper to the soul. For if we are to speak of the spirit spiritually, it is not permissible to speak of the immaterial materially. And since the two coincide by way of representation and analogy, material things are still instruments for the formation of ideas; and when these ideas are grasped in a perceptible manner, then something is perceived which is left to thought alone. The words in common use signify only corporeal and material things, and the modes, qualities, and accidents thereof: and if we are not allowed to use them because of the nature of the objects to be signified, then nothing remains*

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[1] See n. 20, note.

but to be quite dumb and to utter nothing at all, nor even to think, inasmuch as that of which we are to think, must first be insinuated by way of the senses, and by the imagination and representation of things sensible. Things sensible and imaginative may be represented by vocal formulas, from which the mind must afterwards abstract those essences which cannot be elaborated and, as it were, sublimated from any words except by innumerable circumlocutions and modifications. This way of understanding is, with us, the natural way; for we are instructed a posteriori, *and not immediately* a priori. *For these reasons, we are obliged in this preface respecting the seed and its composition, to use words which are not altogether adequate, such as globules, spherules, fluid, membranes, tunics, crusts, figure, space, extension, motion, congregates, volume, and many others, although, properly speaking, such words are not suitable to the soul, nor even to the animal spirit, as I shall demonstrate very clearly in* [*Transaction V*] *Introduction to Rational Psychology. Therefore, for the reasons given above, I pray that this will not be attributed to me as a fault.* No one, indeed, will do this, unless he be of those who hold that nothing is to be said of the spirit, excepting in formulas which are as obscure and abstract as spirits themselves; that is to say, who hold that no expression is competent, that in the least degree involves anything material. Thus every description must be utterly rejected, and we must remain forever in occult qualities. For unless the unknown and occult be signified by the known, as in the calculus, they continue occult forever; and thus the shade is not dispersed, but made more dense.

169. *With these premises, I seem now to be somewhat equipped for proceeding to the description of the seed. Now the veriest seed, which is formed first in the testicles and afterwards in the corpus Highmori and the epididymides and lastly in the ejaculatory or deferent vessels, consists of globules or most pure spherules, the interiors whereof are occupied by the first, simplest, inmost, and supreme substances of the animate body; while the animal spirit constitutes the surface, which extends around like a crust, and perfects the globule.* Here, we at once meet inadequate expressions, namely, globule, spherule, surface, crust, central space; consequently, the idea of space, volume, figure, and so forth. But as I said before, I beg to be excused; I will assuredly satisfy the reader in my explanation of forms, orders and representations. Meantime, necessity forces me to use formulas such as the above, to signify the purest and even spiritual things. It is not granted to any one to speak abstractly, supereminently, and spiritually, but only humanly; although it may be granted to think more purely.

170. *In the very simplest substances that occupy the inmost place, and form as it were the nucleus, lies all that which is attributed to the soul. In this way therefore, it may be said, that it is the soul which occupies the inmost place and that it is so limited by the surface formed by the animal spirit, that it simultaneously represents a most pure globule or little seed, which is the animal principle*[1] *and is most perfectly animate. This first essence, which is the supreme and first essence of every animal, is nowhere so pure, or so gathered together into one unit, as in the testicles, which are formed for the purpose of extracting it from the simple fibres. It is then, straightway, met by the essence of the following degree, that is, by the next lower essence, namely, by that spirit which we call the animal spirit. This comes from the genuine and first compounded fibres, and also from the blood and its resolved globules; and straightway, it rolls around in circles, and produces a species of surface,—which happens in the epididymides, wherein the fibres of the whole testicle and of its nervous or albugineal tunic, and also the purer blood of the spermatic vessels, all run together. And what is commenced in the testicles and epididymides, is perfected in the vasa deferentia, particularly in the more capacious part of their channel and during the whole course of their descent to the vesiculæ seminales.* The reader will find the whole course of the seed's progress described in the Chapters on the Testicles, Epididymides and Vasa Deferentia. *These most pure globules are the genuine seminules and sperms that are fruitful and prolific, and thus carry the soul and life of the parent, and commence and set up the life of the future offspring.*[2] The nature of this first essence which occupies the interiors, is too exalted to allow us to give any idea of it simply and in familiar words. For it is substance itself and formative force, and it draws its stem from the first living point, and continues the thread to the very last of life (*Trans.* I, n. 253). And simultaneously and in the present, it seems to have with it and in it, the ends, as well the first, as the middle and the last, according to which causes follow in a foreseen and certain order, to the ultimate effect (*Trans.* I, n. 260). And it represents to itself the state about to be formed as a state already formed; yea, and the state already formed as one that is about to be formed (*Trans.* I, n. 261). Thus the series of all contingencies for the perfecting of the work of formation, are with it, and in it, in the present (*Trans.* I, n. 263, 265, *seq.*)

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[1] That is, the animal beginning, or the beginning or first of a new creature. See the definition of "principle," in n. 358 below.

[2] In the Latin the rest of the paragraph is printed in italics.

171. *As soon, therefore, as these truly seminal and spermatic substances come flowing together, as is the case in the epididymides and vasa deferentia, they cannot but at once attack and attempt the work of formation; but this only so far as they are provided with a supply of substances similar to those required for the act and progress of formation. But since at this threshold, such substances are lacking, therefore with the help of those that are at hand, they arrange themselves, suitably to the form of the future body in its beginning, into a primitive species of carina,*[1] *like that seen in the eggs of fowls; that is to say, into determinations and fibres that have the appearance of little eels. These, by reason of their intrinsic motion and ceaseless activity, present the appearance of living animalcules, whereas they are only the first determinations and the little stamens arising therefrom, united together into a series of the kind, from which they seem desirous of commencing the first web of the future body. In these stamens, because in each single globule, lies the parent life and soul, but as yet indistinct and imperfect as in a rudiment. They are also most highly active, and deceive the most sagacious inquirers into the belief that the first origin of the fetus is taken from them before it begins in the ovule.* `Leeuwenhoek[2] is wholly of this view, and Boerhaave inclines to the same opinion. For these stamens, by their eel-like form and active motion, insinuate themselves into the senses, and by the senses into the rational mind, in a very vivid way; especially when augmented by confirmation derived from the origin of frogs, which grow up from little eels,[1] and also from a type of similar little eels seen in the incubated egg. Nor can these illusions be dispersed, until we have run attentively through the entire series of formation. For we meet with infinite phenomena which [otherwise] can in no way be untangled; such as the existence and subsistence of the eel-like forms in the vesiculæ seminales, where they abide sometimes for weeks and months, and in the meantime are continually agitated by incessant motion,—both by the intrinsic motion of their parts, and by the external motion of the septa; and again, the fact that they wind their way into the little ovules, which, though impregnated, yet seem to entirely preclude any entrance. On which account, this eel-like form has been more closely examined by the English and other observers, who have likewise used microscopes; and, as a result, it has been found, as Lang says, that it "is nothing else than the active portion of the seed agitated within the viscid molecules, until, being very gradually consumed, there is left a residue of certain motionless fibrils." [n. 162.] And Leeuwenhoek himself, in the very passage where he records his examination of these little eels in the seed of many quadrupeds, birds, and fishes, particularly in the epididymides and vasa deferentia, estimating them in one case at fifty thousand in a space equal to a grain of sand, makes mention at the same time of having seen globules, and even striæ. Respecting the globules, his words are: "Under the animalcules was seen a substratum of numerous and exceedingly fine globules, and also of many plano-oval bodies the circumferences whereof were almost equal in size to globules of human blood; to which globules also life may be attributed, and this by reason of their active motions." [n. 161.] And, moreover, in another place, describing his examination of the nervous juice which escapes from the minutest fibres, he asserts that little eels creep through those very fibres [*Epist. Physiol.*, p. 311];[1] but afterwards he confessed his error, and found that the little eels were nothing more than a continuation and a kind of fibrous cohesion of the nervous humor.

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[1] By the Carina our author means the first rudiment of the fetus.

[2] The Latin has "Malpighi," but this seems to be a slip for Leeuwenhoek. So far as we can ascertain, Malpighi gives no opinion with respect to the seminal animalcules; certainly our author quotes no such opinion.

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[1] *i. e.* tadpoles.

172. *These are the primitive globules, in which lies that vital and natural element that serves for the beginning of formation in the ovum. But since these globules are of the purest kind, highly agitable, and continually in the effort to attack the work of formation wherever they meet with mediate substances, they must be again reduced into a more general and compound form. The case is not unlike that of the primitive seeds of the vegetable kingdom, which are enclosed in a kind of fruity sheath, and are gradually perfected and ripened. For if they were to break out singly and eel-shaped, the work of formation and generation would come to nought. Now, in order to ensure their subsistence and consistence until the time comes that they are to be committed to the matrix and ovum, they are carried down into the vesiculæ seminales, whither several species of suitable fluids and elements are conveyed; and there they are incessantly and distinctly agitated and whirled. By this means these simple forms of the seed are mutually fitted together. Then a number of them, set under a denser membranous crust, are carried round and round; whence arise new and compound globules, which are the true seminal globules.* This is the second degree of composition; for the primitive globules, grouped together to form larger globules, set in orderly arrangement, and surrounded by a more general tunic or crust, thus complete their second dimension. Globules of this order are also seen by the microscope, for they attain such dimensions that they begin to be visible to the sight of that instrument. The means, too, are at hand, namely, a supply of animal spirits, of the purer elements of the blood, and of an unctuous substance from the glands and a watery substance from the fine cellular tissue. Moreover, there is an intrinsic and modificatory motion of all,—a motion which is almost of three degrees, being a motion of the sperms themselves, and of the fibres and septa, and also a more general motion of the membranous envelope which is finely muscular. Hence results a circumgyration of the seminal globules and their determination from cell to cell; thus perfect commixtion. And with the addition of delay, and fomented by incessant heat, the parts are at last suitably fitted together, and the inmost essences of nature,—which alone is determinant and active,—are co-ordinated into forms suitable to their fore-ordained use. During the continuance of this highly active and gyratory state, the little eels in the cells can never remain whole and entire, but, separating into primitive globules, must of a certainty pass over into the genuine forms of the seed. Hence it is that the seed becomes like a humor; for that such it is, is manifest from its consistency, density, color, and other visible phenomena, and also from its chemical solutions.

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[1] Leeuwenhœk's words are: "And although this cavity in the fibrils, a number of which compose a nerve, was so minute, yet I saw living animalcules swimming therein."

173. *Thus the seed is perfected, and at the same time is guarded against all hurtful contingencies during its passage through the urethra, and is also accommodated for flowing into the womb. Moreover, when it breaks out of the vesiculæ seminales, it is besprinkled with a new humor, namely, that of the prostates, and is enveloped therein, lest, escaping from its membranes, it burst forth prematurely, and render the work of generation of none effect. Finally, it is also irrigated and besmeared with another humor in large abundance, which besides adding quantity, also gives it determination whereby it is emitted into its ground or soil, not spontaneously, but by force and in the way of ejaculation.* Respecting all these subjects, see what was said above on the Prostates and the Urethra.

174. *That this seminal material thus perfected and transmitted into the womb, may commence from its first principles to form a new life and a diminutive body, it is necessary that in this its soil or matrix, like the seeds of the vegetable kingdom in their ground, it be again resolved, so far as regards this second composition; so that the naked seminal globules, like a vital aura, may fly off through the Fallopian tubes, into the ovules seated in the ovaries.* That they are resolved, will be confirmed in due course in what follows; and that it is necessary for them to be resolved is confirmed by the parallel case of vegetable seeds. The latter are enclosed in their own proper membrane, and some kinds of them, such as the seeds of grapes and berries and a thousand others, are again surrounded with a dense substance. The reason why vegetable seeds are covered over with a denser coat is because they pass into the genital earth or hard soil. For in all cases there must be mutual correspondence; such as is the soil or matrix such is the clothing that is put on,— and this in order that the interior may be unlocked quickly or slowly, according to the nature of the causes presented in that matrix. The globules thus unlocked or opened, are analogous to a kind of vital aura, being to the last degree light and volatile, and in mobility equalling the auras themselves. Thus also they penetrate through the purest pores of the ovules as through a sieve-like tunic; which would not be the case if they crept up to this point in the form of little eels.

175. *The ovules seated in these ovaries are so formed as to offer the globules not merely an opportunity of insinuating themselves, but also a bosom of the most highly suitable kind,—and this, not only that a number of the globules may therein be again heaped up, but also that they may there procure their first and most suitable nourishment. Thus this first, inmost, supreme, animal essence, in which lies the soul and which is the soul, commences the thread of its formation suitably to its own nature; and first of all conceives and excludes a brain in purest effigy, that is to say, such as it is in the depths of the cortical substance; and then from many such brains, by means of simple fibres, it extends itself to form the carina; and so forth.* This, however, is not the place to show how the work of formation is carried on, but only that all things begin from the first globule as from a little egg; and that the rationale of the whole formation lies in this formative substance, which when thus left to itself, cannot but regard that which is formed as yet to be formed, and that which is yet to be formed, as already formed, and all the several ultimate effects set forth as present in the first representation and intuition, as being, as it were, simultaneously present [n. 170]. This soul, residing in the principles of natural things, regards the whole of nature, as it were, as subject to herself; like one who looks upon the fields from a high tower. Universal nature is but the instrumental cause which ministers to life and necessarily concurs in all its decisions. Thus the whole physical world is completely subject to the moral and spiritual world. There is, therefore, nothing to be met with on the way, that can prevent the soul from passing most freely to ends,—which alone it regards. *The soul, residing in the principles of natural things and holding subject to herself the whole of nature which serves life as an instrumental cause, of her own nature so disposes all things, that to ends shall correspond effects, to which effects she proceeds through the inmost penetralia of the sciences and arts. Thus she weaves the texture of the body, which, to our mind's eye, is full of miracles, as it were; while of her own nature, and without the aid of any previous knowledge of the sciences, she produces similar and still other things in infinite number.* But these are matters of psychology.

176. *If such be the formation, composition and form of the seed, we can then explain the particular phenomena that occur in the genital organs, and also the particular phenomena that occur in conception and generation; and those moreover, that furnish controversies to the world, on the subjects of the formation of the fetus from the seed of the parent, of the evolution of the same in the mother's womb, and of the propagation of the soul into the offspring. For given the above principles, there is nothing that cannot be explained and perceived.* But these particulars respecting the seed are brought forward only by way of introduction or first essay; the several points will come to be further confirmed; and then, if any point, after being duly weighed, should not be consistent [with the facts] it would be the surest sign of hallucination. Meanwhile, it must be assumed,—if not as demonstrated, still as confirmed by all those proofs and phenomena that are at present extant. Granting that this is the case, then this theorem is in the last term of probability, and thus in the first term of truth. To verimost truths, we can never attain, unless we be instructed *a priori*, but not if instructed *a posteriori*. That alone is truth which proceeds from the Divine mouth. Therefore, in what way anatomical proofs, and at the same time, in what way physical proofs, and finally, in what way philosophical conjectures here coincide and, as it were, with united forces fight for this conclusion, will be a matter of later deduction when we come to treat of the soul. In that place we shall again take up the present argument, in order to confirm *a posteriori* the points that lead to our principles.

THE FEMALE ORGANS

AND

THE FORMATION OF THE FETUS IN THE WOMB

CHAPTER X

THE EXTERNAL GENERATIVE ORGANS OF THE FEMALE.

177. HEISTER. (*Compend. Anat.*) The external parts are: The pudendum or *Vulva*, in the middle of which is a fissure and the orifice of the vagina; at the lower part is the *frenum* and *perineum*.

178. The two *Labia* and the mons veneris, swollen by reason of the underlying fat and beset with hairs.

179. The *Clitoris*, or mentula muliebris, situated in the upper part of the fissure, concealed under its skin or prepuce, and for the most part almost entirely outside the stimulus of venery. Its shape and size are about that of the point of the ring finger; sometimes it attains extraordinary dimensions, so as even to equal the male penis, but it has no urethra. Its parts are: A glans, or apex, which, however, is not perforated, but nevertheless is smeared with a fetid humor like the corona of the penis. A prepuce covering the glans, and continuous with the cutis of the pudendum; it is furnished with nervous papillæ and is therefore extremely sensitive. A ligament whereby it is connected with the pubic bones almost as is the case in the penis. Two crura, three times as long as the clitoris itself, and coming from the pubic bone. Two corpora cavernosa with a middle septum, almost the same as in the penis, which make up its substance and are surrounded with a nervous membrane. Two erector muscles,[1] as in the penis, which arise from the ischia and are inserted in the corpora cavernosa. Arteries and veins from the hypogastric and pudendal vessels Nerves from the sacral nerve, considerable branches of which run along the dorsum of the clitoris, whence its great sensitiveness.

180. The *Nymphæ*,[2] which are two membranous parts situated one for the most part on each side of the fissure, reddish, cavernous, resembling the wattles under a cock's throat, sometimes large, sometimes small, continuous with the prepuce of the clitoris, and connected with the inner side of the labia. They are abundantly covered with nervous papillæ, and hence are extremely sensitive. They also have little glands which secrete a sebaceous substance. In addition to the offices of titillation these glands direct the stream of urine.

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[1] The ischio-cavernosi.

[2] Called also the labia minora.

181. The *Orifice of the Vagina* or the external os of the uterus,[1] surrounded with a cavernous substance which swells up during venery, somewhat narrow in virgins, more ample in other women, and those who have borne many children; but always narrower than the rest of the vagina.

182. The *Hymen*, a membrane sometimes circular, sometimes semi-lunar, and sometimes of a different shape, which bars the vagina in virgins, and is always present in young subjects. (This is denied by some anatomists, but Heister has always found it present during the first period of age; and many other anatomists agree with him. *Nota* 30.) It has a small aperture leading into the vagina, but in adults the aperture is larger. Unless previously torn, it is lacerated on the first coition, when it frequently bleeds. The *carunculæ myrtiformes* arise from the laceration of the hymen, and are observed to the number of two, three, or four, in the place where the hymen formerly was. They are not present in the infant.

183. The *Urethra* or meatus urinatorius, directly under the clitoris, its site being marked by a slight eminence. It is about two fingerbreadths in length. Its calibre is larger in women than in men, but is narrower at the end than in the rest of its extent, and admits of great dilatation. There are certain little ducts opening into it, which as in the case of the male urethra, excrete a mucous liquid as a protection against the acrimony of the urine; their origin is not known with certainty. The Graafian lacunæ, that is, the little orifices visible about the urethra, are ducts that excrete a humor for lubricating the vagina. They arise from the glandular substance of the urethra. (n. 234.)

184. WINSLOW. (*Expos. Anat.*) The *Pubes* is that broad eminence on which grow hairs, called in Latin pubes, and almost similar to those found under the armpits. This eminence is a thickening of the adipose membrane, more or less filled with fat, that covers the forepart of the pubic bone and some portions of the neighboring muscles. (*Tr. du Bas Ventre*, n. 624.)

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[1] See n. 219, note.

185. *Labia*, or *Alæ.*—The old anatomists gave the name Sinus to that longitudinal cavity which runs straight down from the middle and lower part of the pubes to within an inch of the anus; and they called the lateral part of that cavity the alæ or wings. The places where these labia or alæ are joined above and below are termed commissures, and may also be called the extremities or angles of the sinus. The labia are more prominent and thicker above than below, but are nearer each other below. They are composed chiefly of skin, cellular substance, and fat. The skin is a continuation of that of the pubes and groins. It is more or less beset with glandular granules, from which may be expressed a white, waxy matter; after a certain age, it is covered in the same manner as the pubes. The inner side of the labia is somewhat like the red portion of the lips; it is distinguished from the neighboring external parts by a kind of line, almost in the same manner as the red portion of the lips is distinguished from the rest of the skin. A great number of pores are observable in it, and numerous little glands are embedded in its substance and furnish a liquor more or less sebaceous. These glands are larger near the edges than in the other parts. (*Tr. du Bas Ventre*, n. 625–627.)

186. *Lacunæ.*—Near the inner edges of the inner surfaces of the labia on each side of the orifice of the vagina, is found a small foramen more visible than the rest. These two foramina are termed lacunæ. They communicate by two small ducts with two follicular bodies[1] lying in the substance of the labia, and which may be looked upon as little prostates, almost similar to the little prostates[2] in man. When compressed, they discharge a viscid liquor. Above the superior commissure a thin, flat ligament runs down from the ramus of each pubic bone, which penetrates the fat in the substance of each labium, and is there lost near the edge. These may be looked upon as the suspensory ligaments of the labia. The inferior commissure of the labia is very thin, almost like a membranous ligament, and at its lower extremity, it forms, with the neighboring parts of the inner sides, a depression termed the navicular or scaphoid fossa. The planes of these ligaments are nearly parallel. The space between the inferior commissure of the labia and the anus is termed the perineum, and is about a large fingerbreadth in length. (*Tr. du Bas Vent.*, n. 628–629.)

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[1] The glands of Bartholin.

[2] Cowper's glands.

187. The other external parts are concealed between the two labia. The clitoris with its covering lies directly under the superior commissure of the labia, the covering being called the prepuce. The orifice of the urethra lies just underneath. Below that again is the orifice of the great canal of the uterus. The circumference of this latter orifice is bordered either by a membranous circle called the hymen or by fleshy portions called the carunculæ myrtiformes. On each side of the clitoris begins a very prominent fold like a crest, which runs down obliquely on each side of the orifice of the urethra, and terminates at the side of the vaginal orifice. These two folds are termed nymphæ, and they might likewise be named the crests of the clitoris. On each side of the vaginal orifice lies the small prostatic foramen already described. (*Tr. du Bas Vent.*, n. 630.)

188. The *Clitoris* appears at first sight like a glans, but imperforate. Above and at the side, it is covered by a kind of prepuce formed by a peculiar fold of a portion of the inner side of the labia. This prepuce appears to be glandular, and it discharges a certain humor. By dissection, we discover in the clitoris a trunk and two branches, almost as in the penis, and in like manner composed of cavernous substance, and with elastic tunics, but without any urethra; also, like the penis, this substance swells up when the artery is injected, etc. The trunk is divided into two lateral parts by a middle septum extending from the bifurcation to the glans where it is gradually lost. The bifurcation of the trunk is on the edge of the cartilaginous arch of the pubic bones. The branches, which also resemble the roots of the corpora cavernosa, are attached to the edge of the inferior rami of these bones, and extend interiorly over the small ramus of the ischium where they gradually terminate; though a portion of the membranous tube on each side sometimes extends as far as the tuberosity of the ischium. The trunk of the clitoris is sustained by a suspensory ligament attached to the symphysis pubis, and which encloses this trunk in its duplicature nearly as in the penis of the other sex. There are four muscles attached to the trunk of the clitoris, two on each side. Two of them, one on each side, run down along the neighboring corpora cavernosa, which they cover in front, and are finally attached by a tendinous or aponeurotic portion, partly to the extremities of the corpora cavernosa, and partly to the tuberosities of the ischium lower down. These two muscles are called Erectors.[1] The other muscles, one on each side, lie immediately below the former; they run down on either side of the urethra and vagina enlarging as they go, all the way to the sphincter of the anus, where they terminate, almost like the accelerator muscles in man. They surround very closely the lateral parts of the urethra and vagina. In their descent, they become broader, and below, they expand over the lower and lateral parts of the vagina; for which reason many anatomists have regarded these muscles as a kind of sphincter or circular muscle.[2] These four muscles are sometimes covered with fat. The bloodvessels of the clitoris come chiefly from the hypogastrics. The nerves arise from the second and third pairs of sacral nerves, and communicate with the inferior mesenteric plexus and with the great sympathetic nerve. (*Tr. du Bas Vent.*, n. 631–638.)

189. The *Nymphæ*, or crests of the clitoris, or as they may likewise be called, the internal alæ or labia, are two folds from the external labia, and extend from the prepuce of the clitoris to the sides of the vaginal orifice. They begin very narrow and pointed, broaden as they descend, and at their lower extremity again contract. They are of a spongy substance. On the inside, they are glandular, the glandular grains being visible to the sight. They are situated obliquely, the upper extremities approximating to each other and the lower separating. In married women they are more or less flaccid or withered. (*Tr. du Bas Vent.*, n. 639–640.)

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[1] The ischio-cavernosi; they differ from the ischio-cavernosi of males only in being smaller; see n. 137

[2] The muscles referred to, are the bulbo-cavernosi, which taken together, are also called the sphincter vaginæ.

190. The *Urethra*, or *Urinary Duct*, is an orifice lying in the interval between the nymphæ, below the glans of the clitoris. It is a kind of cushion slightly wrinkled, and perforated by several small lacunæ from which may be expressed a more or less viscid or mucilaginous liquor. In gravid women, it is sometimes drawn a little inward. The body of the urethra is a spongy canal almost the same as in man, but very short, situated directly under the trunk of the clitoris and above the vagina, so that it is mediate between the two and adherent to both by membranous filaments. It passes under the cartilaginous arch of the pubic bones and terminates by an oblique opening in the neck of the bladder. Between its two extremities it curves slightly downward. Its internal membrane is a little plaited, and is perforated by small holes which communicate with follicles lying in its substance,—as in man. If one of these holes be inflated, a little canal distended by the inflation comes to view, which runs from without inwards, and, in some places, terminates in a kind of ampulla. On compressing these ampullæ, a viscid liquor is discharged. The continuation of this membrane which lines the neck of the bladder, forms several rugæ, more or less regular; but that which lines the cavity of the bladder is wrinkled in an irregular manner when the bladder is empty. (*Tr. du Bas Vent.*, n. 641–644.)

191. The *Vagina,* or *Canal of the Uterus,* also called the neck of the uterus, is situated below the urethra and above the end of the rectum a little obliquely, being more raised on the inner and posterior part than on the outer and anterior. Its inner or posterior extremity is united to the body of the uterus, and engirdles the orifice of the latter much in the same manner as the duodenum engirdles the pylorus, or as the colon engirdles the cecum at the extremity of the ileum. The anterior extremity forms the great orifice which lies under the orifice of the urethra and above the fossula of the inferior commissure of the labia. The body of the vagina is made up of a spongy substance beset with quantities of bloodvessels. It is commonly longer and narrower in virgins than in married women. Its inner or concave surface is more or less wrinkled transversely, and is covered by a particular membrane. The rugæ or wrinkles are formed by somewhat long narrow eminences incurvated like so many arches placed one after the other and so arranged as to divide the concavity of the vagina into two surfaces, an upper and a lower. The meeting of the extremities of the upper rugæ with those of the lower forms an irregular suture on the right side and on the left. The arches are sometimes broken in the middle and divided into semi-arches, but in this there is some variety. In young girls and in virgins, the rugæ are quite prominent, but in married women they become more superficial, and they are effaced by parturition. The inner or posterior extremity of the vagina surrounds the orifice of the uterus obliquely, in such manner that the upper wall of the vagina is nearer the orifice, and the lower further away; this causes the extremity of the uterus to appear to be nearer to [the wall of] the vagina, or canal, below than above.[1] (*Tr. du Bas Vent.*, n. 645–652.)

192. *Circulus Membranosus,* or *Hymen.*—In virgins, and before menstruation, the anterior extremity of the uterine canal is ordinarily bordered by a membranous fold, more or less circular, large, and smooth; sometimes it is semi-lunar. In some subjects it leaves a small opening, in others a larger one, and it causes the external orifice of the vagina to be narrower in diameter than the rest of the cavity. This fold is the hymen, which is formed by the union of the internal membrane of the canal with the internal membrane of the labia. It shows as a membranous circle. (*Tr. du Bas Vent.*, n. 653.)

193. *Carunculæ Myrtiformes.*—The hymen is ruptured in coition, and effaced by parturition, leaving only some irregular-shaped fragments, which [from their supposed resemblance to myrtle leaves] are called carunculæ myrtiformes. The hymen may also suffer by too great a flow of the menses, by accidents, imprudence and levity. (*Tr. du Bas Vent.*, n. 654.)

194. *Plexus Retiformis.*[2]—Each side of the anterior portion of the vagina is covered exteriorly by a thin, broad, cavernous and vascular plexus, called the plexus retiformis. These two planes run down on each side of the clitoris behind the nymphæ, and in their passage they cover the urethra like a collar, before they are spread on the great canal or vagina. This plexus is closely united to the inner surface of the muscular ring[1] commonly taken for accelerator or constrictor muscles, and thus lies between these muscles and the lateral parts of the urethra, and of the great canal. When inflated, the substance of this plexus is swollen like a flaccid spleen, and almost like the spongy substance of the clitoris, with which it seems to communicate. This gives the reason for calling the lateral portions of this reticular plexus the internal crura of the clitoris. It is a kind of rete mirabile of vessels which come chiefly from the hypogastrics. (*Tr. du Bas Vent.*, n. 655–657.)

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[1] See Plate IV. fig. 2.

[2] The plexus retiformes, or reticulares are the same as what Heister calls the corpora cavernosa of the clitoris, see n. 179 above. They are now known as the bulbi vestibuli. These bulbs were also called the internal crura of the

195. Schurig. (*Muliebria.*) Cases where the *perineum* has been ruptured in child-birth; also by the presence of wind. —Calculi extracted through the perineum. (I. iv. § 2, 6, 11.)

196. *Vulva.*—Large vulvas.—Fire issuing from the vulva.—Double vulva;— the same in lizards, crabs, rayfish.—Vaticination by the vulva.—Prurience of the vulva;—inflammation; fungus.—The passage of feces through the vulva.—The vulva is sometimes closed up. (I. v. § 6, 11–16, 18, 21.)

197. *Clitoris.*—A bony clitoris.—The size of the clitoris varies.—It is the cause of pleasure.—Large clitoris in infants;—in adults;—so large as to hinder walking.—Is a large clitoris a sign of hermaphroditism?—There are tribades, women who lie with women. (II. i. § 7, 8, 10–13, 15 *seq.*)

198. *Nymphæ.*—The nymphæ are little membranes, generally of a fleshy texture, always acuminated below and broad above. In virgins, they look like a ligament, suspending and, as it were, constricting and closing the lower part of the external orifice. Above, they are joined together at an acute

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clitoris. Taken together, they correspond anatomically to the corpus spongiosum of the penis, while the two external crura of the clitoris, now called simply the crura, correspond to the two corpora cavernosa. Cf. n. 138, 141.

[1] This muscular ring is formed by the two bulbo-cavernosi muscles, see n. 188, note.

angle where they form a corrugated membranous process which invests the clitoris like a prepuce. In young subjects they are soft, but in course of age and by frequent coition they are indurated and become almost cartilaginous. The above is according to Riolan.—They vary in size and shape.—[According to Dionis, they are unfolded at the time of childbirth in order to allow of greater extension to the labia majora.] On opening the bodies of females soon after childbirth, he found them almost obliterated.—The circumcision of women among the Persians and Ethiopians, consists in the amputation of the nymphæ. (II. ii. § 3, 4, 8, 10.)

199. The *Carunculæ Myrtiformes* are single in virgins, and multiple, up to the number of four, in married women;—there are also an equal number of fleshy membranes for their attachment.—But they appear to consist of the rugæ of the vagina.—They are said to arise from the breaking of the hymen.—They bar the orifice of the cervix. (II, iii. § 1, 2, 4, 5.)

200. *Prostates.*[1]—De Graaf says that the prostates have an irritant function; for their pituito-serous humor, by its acrimony and saltness, renders women more salacious.—Some authors erroneously regard it as the female seed.—The seat of female gonorrhea is in these prostate glands. (II. iv. § 7, 9, 10.)

201. *Hymen.*—The substance of the hymen is variously described as membranous, nervous, fleshy, ligamentary, venous, retiform.—Some writers say that it is thick, others that it is thin.—Sometimes it wholly precludes the passage.—Some deny its existence.—Some say that it consists of the carunculæ. (II. v. § 8, 10, 14, 16.)

202. The *Vagina* lies between the bladder and the rectum. In virgins, the orifice is much narrower than the body of the vagina.—It is rather long, but somewhat contorted and oblique. Except in coition, its sides are somewhat flaccid and collapsed, like those of the intestines; but the opposite is the case during menstruation, coition, and parturition.—It is about four inches long, and half an inch broad; after child-birth it is larger.—In the venereal orgasm, it answers to the virile member, which it closely embraces.—In its lower part are found many little pores whence comes a humor whose issuance is attended with great pleasure.—The glands are in clusters like grapes.—In some subjects a fleshy excrescence has been observed in the vagina.—Rupture of the vaginal wall facing the rectum has also been observed. (III. i. § 4–7, 11, 14, 16.)

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[1] The glands of Bartholin.

203. BOERHAAVE. (*Instit. Med.*) In women, the blood vessels and lymphatics, adipose and nervous vessels, membranes, fibres, are far more lax than in men. Hence all the cavities, cells, vessels, are more readily filled and their humors aggregated. And therefore in women the cellular and adipose membrane is always very thick. (n. 661.)

204. MORGAGNI. (*Advers. Anat.*) Besides the lacunæ belonging to the glandular substance of the urethra, I have not unfrequently found several foramina disposed about the beginning of the vagina, just in front of the hymen or of the carunculæ myrtiformes, or of the place where the latter should be. I have counted two, three and also four of them on each side. Not long ago, I saw a foramen almost under the glans of the clitoris, in which terminated a short duct placed transversely. Sometimes the foramina are covered by the carunculæ falling forwards over them. Each of these foramina admitted a coarse bristle. Some of them run upwards, some downwards. I saw one duct on each side, which belonged to a roundish gland of no mean size, wherein, instead of a receptacle and cavity, were found several vesicles or cells opening into each other, and filled with a limpid humor. These were the beginnings of the duct. (I. § 31, p. 42, 43.) Horne and De Graaf assert that a pituitous serum may be elicited from the little foramina in the cervix of the uterus. Others deny this [asserting that the humor is glutinous and viscid]. Morgagni also found in the top of the vagina, and also in the cervix, a sluggish humor which was limpid, except that it inclined somewhat to a yellow hue. He also noticed certain vesicles of various sizes, all however, roundish or oval, occupying in close groups almost the whole internal surface of the cervix; they are the sources of a humor or fluid. Some anatomists consider them as hydatids, but this Morgagni denies. He says that the use of this sluggish and glutinous mucus is to conglutinate the orifice of the uterus during gestation. (I. § 32, p. 43, 44.)

205. *Nymphæ.*—With respect to the nymphæ, there is great variety. Their glands are sebaceous. Moreover, on the whole surface of both alæ, excepting their extreme borders and upper portions, are great masses of glands. They are small, but when the ala is stretched, there is seen at the center of each a little orifice from which issues a whitish and very delicate thread of the same hue as the glands. The latter are sebaceous glands. (I. § 11. p. 8.)

206. *Clitoris.*—A suspensory ligament is attached to the clitoris in the same manner as to the penis. (I. § 18, p. 20.) In cows, dogs, sheep, etc., the clitoris is set in the inferior extremity of the parts. (IV. § 23, p. 42.)

207. The *Hymen* reaches all the way to the meatus urinarius, although in proportion as it mounts it becomes thinner and finer, so that it appears to resemble a crescent moon rather than a ring. From the upper and inner part of the vagina, following its longitudinal direction and tending towards the hymen, descend two, three, or sometimes more columns, or, if you please, corrugations of the doubled inner substance of the vagina. In their descent these columns leave a considerable space between them. The nearer they approach the hymen, the thicker they become; and for this reason the vagina becomes narrower toward its lower part. The extreme bases of the columns, because of their shape and size, may be mistaken for the carunculæ myrtiformes by many anatomists, to wit, by those who affirm the hymen to be nothing else but these carunculæ mutually bound to each other by membranes, —in which opinion, however, they are mistaken. (IV. § 23, p. 43-44.)

INDUCTION.

208. *The female parts answer to the male just as though they had first been naturally united and then naturally separated; and as though when united, they had resembled only a single body, but when separated, two bodies. The female parts therefore are fashioned entirely for the reception of the male; and for co-adaptation and unition with them; for the promotion of co-operation between them; and finally for the gestation of the fetus, and its delivery. To these qualifications are added bland, impulsive causes, both in the body and in the animus, and even in the soul itself; yet with a difference like that between active force and passive force, and between essence and form,—passive force and form being also naturally reactive; fròm which two principles mutually conjoined, results a unit, which in itself is perfect and from which is finally produced a third.* But to come to the several points. In general, it is a constant truth that for the existence of a perfected thing, there must be an agent and a patient; and therefore, since everything in nature aspires to self-perfection that which is active has an appetency for the passive, and *vice versa*. But on these subjects see our Introduction.[1]

209. *The female parts so correspond to the male, that during the time of carnal copulation, they resemble not two bodies, but one, and so coalesce, that at the moment of orgasm, the two scarcely know other than that they are one; moreover, nature at the same time endeavors to actually unite them. For love, and particularly venereal love, is the closest union of wills and minds* (animus),—*a union so close that the life of the one is in all ways communicated to the life of the other, so that in the ecstasy itself, whatever is peculiar and proper to either is mutually reckoned as belonging*

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[1] The reference is probably to Trans. V "Introduction to Rational Psychology." See n. 20, note, and Index of Authors, s. v. *Swedenborg*. Dr. Wilkinson conjectures that the reference is to the Introduction to Rational Psychology in ECONOMY OF THE ANIMAL KINGDOM. See ON SENSATION, OR THE PASSION OF THE BODY, (in Posthumous Tracts), and also RATIONAL PSYCHOLOGY, n. 23.

to the other. It has been shown above [n. 45, 46, 145], that at that moment the soul strives to go forth out of its body, and to as it were found a colony. For the universal simple fibre which is the determination of the purest essence and which, taken substantially, is the soul, opens up in all directions, and endeavors to transfer itself to another; but it is provided that nothing of the soul shall emigrate, except that which is entrusted to the testicles, see above [n. 46]. Were it not for this provision, the ardor is so great, that the whole vitality and the entire animal principle would emigrate,—as is evident from the several phenomena of the act. For at that time, each is as it were forgetful of self, and believes that he belongs to the other. Thus the nature of the communion between the two minds (*animus*), cannot be better seen than from this venereal heat and from the actual copulation. At this time each belongs, not to himself, but to the other; and so long as this state is reciprocal, the property or proprium of each becomes the common property, which it is hardly possible to perceive as being distinct. *This union of minds* (animus) *is represented physically in the union of the bodies, and of those members that serve and minister to the union. For in order to a perfect union a whole series of unions must be formed from firsts to lasts, to the end that all the particulars may plead a single cause. For the soul and its representation, the mind and the desire of its will, the animus and its longing, and the body and its pleasure, must all concur, and complete the series,—a series which, although in itself successive, must be simultaneous, so that if representation or desire, or longing or pleasure be taken away, the communion and consequently the co-operation, must at once cease.*

210. *That the female parts are exactly fashioned for the reception of the male is clear from the several forms and types of the female receptacle, from the extreme fissure even to the inmost cavity of the uterus. The dimensions of the parts correspond to each other, and if there be any difference, the female parts are adapted for enlargement and constriction, and by their very nature, they open up, and seize and embrace the male parts and are closely fitted thereto. This is the end and object of the fissure at the orifice, of the nymphæ, of the carunculæ, of the folds of the vagina, yea, and also of the penis-like clitoris itself.* For there are, as it were, three gates to the womb. The first is the fissure, which first receives the male organ and closely seizes and embraces its root. The nymphæ which form an almost similar fissure, constitute the second gate, and further seize and close over the male organ. The third gate is the vagina itself, the orifice of which is comparatively narrow, but the tube more ample. At the age of virginity, this last gate is closed by the hymen, as though it were a sacred entrance, and afterwards, it is guarded by the carunculæ myrtiformes. The vagina itself is of such a structure that it suffers itself to be expanded by the size of the organ which enters it, so that it closely grasps that organ throughout its whole extent; for its rugosities and folds are of a spiral kind which, while offering opportunity for expansion, are yet in a continual effort to attain a smaller dimension. A like effect is produced in the orifice by the carunculæ myrtiformes, which have a kind of muscular tissue wrought into their fabric as well as into the orifice itself; for the chief object here is the just application of the orifice. Moreover, the outer surface of the vagina is of a cavernous structure, which renders its expansion easy. The clitoris too coöperates; for when the orifice of the vagina enlarges, the clitoris also increases its whole dimension, as is clear from the application of the muscular fibres. The muscles known as the accelerators, correspond to the accelerators in the male organs, and by their fibres they embrace the clitoris and are also applied to the orifice of the vagina. Thus, when that orifice is expanded, the muscles are relaxed and room is given for the expansion of the clitoris. That it is the muscular fibre that limits the expansion of the clitoris and constricts it, thus preventing it from swelling beyond its due size, see above in the chapter on the penis [n. 148]. A like action results from the muscles of the clitoris called the erectors, and also from its suspensory ligament. Thus the very opening and expansion of the orifice of the vagina, affords to the clitoris the opportunity of swelling up. In this way, the clitoris also contributes to the application of the vagina to the male organ, or rather, to the application of the vaginal orifice, and also of the nymphæ. The nymphæ likewise, together with the fossa navicularis or scapha, contribute their share to the faculty, not only of expansion, but also of extension enjoyed by the several parts. For the nymphæ are folds of the same membrane [as that of the vaginal orifice], and although they are coalesced, still with the increase of the expansion and extension, they set themselves loose, unfold, and adapt themselves to the several parts, while at the same time continually striving to attain a smaller dimension. Thus all the parts are fashioned for the reception of the male organ, and for co-adaptation with them.

211. *Nor is it only reception and co-adaptation that they conspire to and strive after, but also absolute union. To this end a viscid humor three-fold in kind, is excreted in abundance, and when excreted, flows around in every direction. This humor not only smears and fills up all the spaces where the parts are not in close apposition, but also endeavors at the critical moment to entirely unite the one being to the other.* Innumerable ducts and pores are visible, from which this humor issues, namely in the vagina itself, that is, on its internal surface as shown by Morgagni [n. 204], and also close under the carunculæ myrtiformes. Of the pores in the latter place, which are more open and are called lacunæ, Morgagni enumerates as many as four. These ducts terminate in follicles and also in the prostates. There are moreover pores and ducts in the urethra itself, in whose cavity are seen numerous orifices, just as in the male urethra; from which orifices trickles out a viscid humor. Besides these, there are also glandular granules in the whole cavity, the nymphæ, the labia and the other parts. Thus a copious afflux of humor is at hand which flows around the male organ, and causes a union so close that not the smallest portion of air can penetrate. This humor is not a seminal but a conjunctive humor; for in no way does it commingle with the male seed. It seems to be of three kinds: That which comes from the vagina and urethra, and perhaps also from other sources, is a thin glutinous serum and appears to be expressed from the cells and follicles, or from the cavernous portion of the clitoris, of the external surface of the vagina, and of the urethra. The second kind is a little thicker, being that which comes in from the so-called prostates through the lacunæ. Lastly, there is a sebaceous and waxy matter coming from the glands. These humors appear therefore to differ from each other in grossness and density, but all three are of such a nature, that they are plainly viscid and conjunctive like glue. For they are humors which, together, must not only unfailingly produce the effect of filling up the empty cavities, but must also for the moment endeavor to conglutinate the active viscera to the passive,—although provision is made that this effect shall never be actually attained. This follows inevitably from the very nature of venereal love, whose criterion and attribute it is, that perfect union and communion shall exist; and this induces a necessity also on the physical organs, which correspondingly endeavor to produce a similar union. The effect is known from the cause, and the cause from the effect. The viscid nature of the humor we are describing is plain enough; so also the viscid nature of the human seed, which when dried on the linen, has the appearance of a kind of glue. This property however does not prevent the humor from serving as a lubricant to the passage, for the more easy performance of the act. For whatever nature produces, involves not merely one end, but many intermediate ends at the same time, and thus, together with the primary use, many secondary uses. And so the humor of the urethra is not only for the purpose of guarding this pathway against the acrimony of the urine, but at the time of coition it serves also to increase the mass of the humor; for when, during the act, it flows into the urethra, it there adds itself to the other humors, and appears to be of a similar nature.

212. *These same organs and several others, together with the humors that issue from them, foment and excite desire, pleasure and lust, even to the last effect, heat or fire, so that the end follows of necessity. There is an entire series of excitements and allurements; for there are inmost, middle and outmost excitements, or first, posterior and ultimate, all of which simultaneously concur to the act and in the act. The inmost excitements are those that have their seat in the soul and mind, whence nature, ever prone to the propagation of offspring, is excited by her own proper cause. The middle excitements are those that kindle the animus, whence comes burning desire, arising from the allurements of the senses, from sight, hearing, touch, and consequently from an imaginative power which derives its existence from sensation. The last ex-*

citement is the actual contact in the venereal heat, that is to say, when the sensitive papillæ which beset the labia, alæ, nymphæ, and vagina are roused and stimulated by the continual touch and attrition, both of the soft, smooth penis, and of the interjacent acrid and salty humor. Comparing these excitements with similar excitements in the man, it is plain that women are more prone to the heat of venery, and more vehement, and therefore less at their own command than men. The incitements to venery, and the abundance and nature of these incitements, enable us with some certainty to draw a conclusion with regard to the degrees and differences of desire. I canvas only those excitements that arise from mere touch and which are all external; for internals so correspond to externals that from the latter a conclusion can unhesitatingly be drawn with regard to the former.[1] In the female, the external excitements comprise all those papillary, nay, and all those glandular forms, which are visible; those namely, in the nymphæ and throughout the cavity of the vulva, and which anatomy shows to be of a papillary nature. There is also the internal tunic, which being tender and soft and composed of mere fibres, is more sensitive than the cutis, which latter is covered by the epidermis. The prepuce of the clitoris which is continuous with the nymphæ, is likewise most liberally furnished with papillæ. The vagina itself is also nervous and papillary; see Heister [n. 215]. Moreover the host of nerves arising from two pairs of the sacral nerves and from the inferior mesenteric plexus, and consequently from branches of the intercostal and par vagum,—that is to say, from the sympathetic nerves,—and which, mounting the clitoris, almost entirely constitute what is termed its nervous coat and even its very cells, confirms the same thing [with regard to the seat of the external incitements]. See respecting the corpus cavernosum in the chapter on the Penis [n. 145–159, and particularly n. 149, 151]. The whole female penis, that is, the clitoris, is therefore constructed solely to the end of venereal excitement; and together with the cavernous body of the urethra [n. 190], the cellular body of the external surface of the vagina,[1] and the nymphæ, and perhaps also the carunculæ myrtiformes, swells up,—and this still more extensively when the vagina stands wide open; see above [n. 91, 146, 153]. The result of all this is that a sharper sense of touch is engendered in the papillæ and in the several organs. The glans of the clitoris is the main organ of excitation; for it is applied to the hairy portion of the pubes of the male, and is excited to this lust to the fullest extent according to the degree of its extension. Indeed this glans is applied to the outmost part of the man, at the same time that the glans of his penis is applied to the inmost part of the woman; thus the union is absolutely complete, and is attended with supreme allurement on both sides. Furthermore, the circumfluent humor by reason of its acrimony and saltness, rouses up the whole papillary sense in the minutest parts; for whilst the male member by soft contact produces this effect in general, this humor, by the individual touching of every single papilla, produces the same effect [in particular], and thus multiplies the feeling. But in man there is scarcely a part that is sensitive except the glans of the urethra; it necessarily follows, therefore, that desire excites women more vehemently than men. From these considerations, we may conclude that the more remote or internal causes stand in a like degree; for internals and externals are always mutually correspondent. This is further confirmed by the fact that the nerves of the female sex are more tender and lax, and thus more prone to assume that state at the first influent cause. Such is the state, that, at the giving of the first signal or the flowing in of the first allurement, the fibres are more readily expanded, and more readily vibrate. In the same ratio also, the papillæ in the female sex are more sensitive [than those in the male] and therefore excel them both in quantity and quality. The subjects of this passion themselves say and attest as much from fact and experience, and furnish us with confirmation. The cause of this surpassingness of desire will be discussed presently. Moreover, there is a series of causes that must concur simultaneously to one effect,—causes, that is to say, from the soul, from the mind, from the animus, and lastly from the senses or the body (see this explained above [n. 149, 151]); and there must be as many incitative or impulsive causes as there are causes in the one series. For the first cause cannot produce the second immediately, but the superior merely communicates a nature to the posterior whereby the latter, excited by its own causes, rushes with greater proneness into the effect [see above n. 149]. The universal cause flows into the posterior cause in no other way than through the latter's natural disposition or inclination. Thus if there be a number of degrees in one series, there ought also to be an equal number of impulsive causes (so the middle causes are termed), that enter in by the doors of the senses and by way of the imagination; and also of ultimate causes that enter in by touch, particularly by the touch of the members of the organ dedicated to transmission and reception; hence those delicious ecstasies which the whole world so vehemently loves.

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[1] The Latin is *ex illis ad hæc* (from the former to the latter), but this seems to be an error.

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[1] The bulbus vestibuli; see n. 194, *cf.* also n. 191.

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213. *Venereal love, therefore, springs indeed from the same causes in both sexes, but nevertheless, in its principles, it is not entirely of the same nature in each. In man, the first cause of this love is the propagation of offspring for the sake of earthly society, and more remotely, for the sake of heavenly society; in woman, however, while it is for the same causes, yet it exists in her, not as in a principal cause, but as in an instrumental cause; to the end, namely, that she may receive that cause not as native to herself, but as a cause to be implanted in her by her husband; and thus may perfect that which is begun by her husband, and which flows immediately from him. These ends, therefore, in the one sex, and in the other, correspond to each other, like active forces to passive, which, when united, produce one cause. Of this nature also is the love of the one towards the other, which love requires to be stronger in the female sex, since this sex is excited not by active principles, but by passive. And in order that the woman may be suitably excited, and be subject to the active force and the will of her husband, it is necessary that her nature be such that her will be subject to the affections of her animus, but these affections to the will of her partner, and the will to his reason. To the end that this effect may be attained, women are given excitements more numerous and of more exquisite sense, in order that they may be less under their own judgment, and may depend on the judgment* *of another as their ruler. From these considerations a conclusion may be reached with respect to the nature of the conjugial consortship instituted by nature, namely, that it is such that the wife shall obey and the husband command, so that when they are of one mind she shall be passive, while he is active; otherwise order is perverted and nature changed around. A husband also naturally pardons his wife, if she succumbs to faults arising from the changeable nature of her animus so prone to emotions and affection.* Hence also comes the more ardent love of the mother towards her offspring, and the greater constancy of her affection,—for she is more readily excited by internal and external causes, and it is native in her to conceive, form, and bring forth offspring. Whatever is formal is hers, but the essential is her husband's; and the formal constantly excites, but not so the essential, which goes deeper and is finally lost; so that, as regards the husband, it is the formal that must at last continue the parental affection or storge.

214. *Moreover, the external female organs are formed with a view to excluding the fetus that has been conceived and matured; in order, namely, that for the sake of birth, the vagina may be capable of expanding as the labor requires, and the other cavities of yielding and making a passage.* This is the reason why the vagina on its inner surface is provided with such numerous fissures and semicircular folds, and on its external surface with cellular tissue; nay, for this reason also are the carunculæ, the nymphæ, and the navicular or scaphoid fossa; for all these foldings give a faculty of expansion. At the time of delivery, all the folds are smoothed out and disappear, being merged in the great canal; they yield as soon as the membranes break and the child begins to come down; to say nothing of the other appended parts, such as the pelvis, and the yielding bladder and intestinal tube, between which the vagina is extended. But since the several parts are in the effort to regain their smaller dimension and their pristine state of contraction, they therefore afterwards relapse by means of the aforesaid foldings; this we may infer from the nature of the parts themselves. *To say nothing of the other natural discharges to which this same cavity also affords a passage; such as the lochia and the urine.* But I do not venture to treat further in detail of

the several uses and the several parts, lest perchance I hurt that modesty and chastity which ought to be observed. Let us rather pass on to the uterus, for the inner parts assail the senses less than the outer.

CHAPTER XI

THE VAGINA AND CERVIX OF THE UTERUS[1].

215. **HEISTER.** (*Compend. Anat.*) The *Vagina* is a large canal, not greatly unlike the rectum, though more robust. It extends from the orifice of the vagina to the uterus, lying between the bladder and the rectum, to which organs it is adherent. Its length, when not stretched, is about six or seven finger-breadths. Its calibre is larger than that of the small intestine; under different circumstances, particularly at the time of delivery, it is apt to undergo great dilatation. Its orifice is narrower than the rest of the canal, and is contracted by a sphincter. Its substance is membranous, wrinkled, nervous, and papillary on the inside, and hence extremely sensitive; on the outside, it is muscular, and by this means is enabled to blandly embrace the penis in coition. It is connected in front with the bladder, and behind, with the rectum; above, it is attached to the uterus. It has wrinkles or rugæ, which are not circular, but are very like those in the jejunum. They are largest, particularly in the anterior part, in virgins; in women who frequently transact venery, they are smaller, and, as it were, rubbed down; and after several parturitions they are almost entirely obliterated. Lacunæ or oscula are found here and there about the orifice of the vagina, just as about the urethra, being often large enough to admit a bristle. The greater part of them come from the underlying glands called Bartholin's prostates, which secrete a mucous liquid for lubricating the vagina. The sphincter muscle or constrictor of the vagina,[2] is a series of muscular fibres, arising from the sphincter of the anus, embracing the orifice of the vagina, and inserted under the clitoris and its crura. The orifice is also surrounded by a cavernous substance,[1] which, being distended with blood during venery, contracts it so that it affects the male penis with greater pleasure, and is itself pleasurably affected. (n. 235.)

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[1] Our author entitles this chapter, "The Uterus;" but as a subsequent chapter is also headed "The Uterus," it seems advisable to here supply another title. Moreover in a MS. where Swedenborg enumerates the chapters of the work on GENERATION, this chapter is entitled "De Vagina Uteri" (6 Phot. MSS., 349). See Preface, and confer also n. 240 *fin.*

[2] See n. 194, note.

216. The *Uterus* or *Matrix*[2] is a part situated between the bladder and the rectum; is hollow; in shape like a pear, slightly compressed; and dedicated to the generation of the fetus. Posteriorly, it is free; anteriorly, it is united with the vagina; and laterally, it is attached by two ligaments,—the broad and the round.[3] The *broad* ligaments are membranous, are continuous with the peritoneum, and on each side they join the uterus and vagina to the walls of the pelvis; they consist of two membranes, between which, almost as in the mesentery, lies a cellular membrane easily discovered by inflation. The *round* ligaments rise from the upper part of the uterus, pass through the abdominal rings, and afterwards terminate in the fat about the groins. Each ligament consists of two membranes, a vascular plexus, and strong fibres, especially conspicuous in and before childbirth. The uterus is about three inches long; two inches broad in the upper part, and one in the lower; and half an inch thick. In virgins it is still smaller; but in pregnant women, it varies according to the period of their pregnancy. The upper and broader part is called the fundus, and the lower part, the cervix or neck. After the vagina has been opened, there is seen in the cervix: the internal orifice, or os of the uterus, standing out into the vagina almost like the glans penis in shape.[4] It is extremely small in virgins, but somewhat larger during pregnancy and in women who have borne children; during pregnancy, moreover, it is closed by an extremely glutinous humor. In childbirth, however, by a miracle of nature, it gives passage to the grown fetus. It is of a muscular substance made up of various meshes of fleshy fibres interwoven with vast multitudes of bloodvessels. In non-pregnant women, it is compact and firm; in the pregnant, it is spongy, full of sinuses, and susceptible of wonderful dilatation without any lessening of its thickness. ([Some writers affirm that the substance of the uterus is thinner during pregnancy, but] Deventer and Heister have never found it thinner at this time, but have frequently found it thicker [and in this, they are supported by many anatomists]. *Nota* 31.) Externally, it is covered by a strong membrane from the peritoneum; and internally, or in the cavity, by a porous nervous membrane, which seems to disappear in childbearing women.[1] (n. 236.) Ruysch has delineated, in the fundus of the uterus of pregnant women, certain spiral or orbicular fleshy fibres, which he calls the new orbicular muscle of the uterus,[2] and to which he ascribes the power of separating and expelling the placenta from the uterus after the birth of the child. But Heister, in his examination of gravid women, has not been able to find this muscle, but has found only some muscular fibres stretched round about in various directions in an inextricable mesh. (*Nota* 31.)

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[1] The bulbus vestibuli, see n. 188, note.

[2] Plates IV and VI.

[3] Plate VII, fig. 1.

[4] See Plate IV, fig. 2.

217. The *bloodvessels*[3] of the uterus,—tortuous, forming innumerable anastomoses with each other, and in women with child, dilated into, as it were, sinuses,—open by little mouths into the uterus and vagina, and are the sources of the menstrual discharge. (Physicians are not agreed as to whether the menses come from the uterus or from the vagina. Morgagni shows that they come from the fundus of the uterus, but never from the vagina. Littre and other writers say the same thing. *Nota* 32). The arteries of the uterus are: 1. The spermatics[4] from the aorta. 2. Very large vessels from the hypogastrics.[5] 3. Vessels from the external hemorrhoidals.[6]

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[1] The membrane referred to is the inner or mucous membrane of the uterus; see n. 228, and 312, note.

[2] The plate referred to is a life-size presentation of the inner surface of the fundus of the uterus, showing a vast multitude of delicate muscular fibres, which, by their spiral arrangement, present the appearance of a whorl or vortex. See the plate itself in Ruysch's work, DE MUSCULO IN FUNDO UTERI REPERTO, Amsterdam, 1742.

[3] See Plate VI, fig. 2.

[4] In women, they are now called the ovarian arteries.

[5] The uterine arteries. From the hypogastrics or internal iliacs also come the vaginal arteries which anastomose with the uterine.

[6] The external hemorrhoidal is now distinguished into two vessels, called the middle and inferior hemorrhoidals. They consist of the terminal branches of the internal iliac in the neighborhood of the bladder and rectum.

All these vessels are in such wonderful communication with each other, that if any one of them be inflated, or be injected with wax or mercury, all the others, even those of the opposite side, are quickly filled. The veins also are threefold, and have the same names as the arteries. They have no valves and are much larger than the arteries, especially in women with child. By inflating them, air may be thrown into the cavity of the uterus and vagina; and on the contrary, through the latter it may often be thrown into the veins. The uterine *nerves* are from the intercostal and sacral nerves. (n. 236.)

218. There are little orifices between the rugæ or valves of the cervix of the uterus;[1] these appear to be ducts secreting a glutinous liquid. Vesicles or globular corpuscles are sometimes observed in the cervix and orifice of the uterus, which contain a mucous humor. Many anatomists have regarded them as hydatids; some consider them as the glands that secrete the glutinous liquid which closes the os uteri during pregnancy; others as a new and true ovary in which the fetus is fashioned; by some they are called the vesiculæ seminales of women, and are supposed to pour out a prolific seed during coition. They are most numerous in childbearing and pregnant women, in whom also they are more than usually conspicuous. (n. 236.)

219. Winslow. (*Expos. Anat.*) The *Uterus* lies between the bladder and the rectum. It is about three inches in length, two in breadth at one end, and scarcely one at the other, and one in thickness; but its size varies with the age of the subject. It is situated obliquely, so that the fundus lies behind and above, and the neck in front and below; the broad parts lie next the bladder and rectum, and the narrow parts are at the sides. In the natural state the internal orifice[2] of the uterus is narrower than the duct of the cervix. At the edge of this orifice are several little foramina, answering to the same number of glandular granules, and which discharge a glutinous lymph. The inner surface of the uterus is lined by a very fine membrane, which at the fundus is smooth and even, but towards the orifice is wrinkled in a peculiar manner. That portion of the membrane which covers the fundus is perforated by a great number of foramina, through which, when the uterus is compressed, are squeezed drops of blood. Sometimes it appears to be furnished with very fine little hairs or villi, as though it were a villous membrane. These villi and foramina are more or less red and tinged with blood in women who die during the period of the menses. The walls of the cervix are divided into two lateral parts by a kind of prominent longitudinal line, which is larger on the upper or anterior side than on the lower or posterior. On each side of these lines, are certain obliquely transverse lines or little rugæ, more or less irregular, and disposed like branches, of which the longitudinal lines represent the trunks. Between and around these rugæ are small lacunæ, from which issues a mucilaginous humor which closes up the orifice of the uterus. In the interstices between the rugæ are several small globular and transparent granules. (*Tr. du Bas Vent.*, n. 590–591, 594–598.)

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[1] Plate IV, fig 1; Pl. V, fig. 3.

[2] By the term *internal orifice*, or *internal os* the old anatomists signified the orifice between the cervix and the vagina. This is now called the *external os*,—the term *internal os* being given to the contraction of the cervix at its uterine extremity (Plate IV, fig. 1). Formerly, this contraction received no particular name, beyond being described as the beginning of the cervix, and the place where the cornua of the uterus come together (n. 229). The opening between the cervix and the vagina was called, in general, the os of the uterus. More particularly it was

220. *Structure.* The substance of the body of the uterus is spongy, and compact with a copious intertexture of vessels. Its thickness is nearly uniform on the sides and edges. The fundus is thicker toward the middle than towards the two angles;[1] the edges also become thinner toward the angles, but not much thinner near the extremity of the neck. The uterus is covered by a portion of the peritoneum, which serves it as a coat, and is the continuation of that which covers the bladder and rectum; running up from the posterior and lower part of the bladder, it passes over the anterior part of the uterus; from

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called the *internal os*, but this nomenclature regarded the vagina as the great neck or cervix of the uterus—a name which, indeed, it sometimes received,—and its outer orifice was then called the *external os* of the uterus (n. 181.)

[1] *i. e.*, towards the openings of the Fallopian tubes.

thence it goes over the fundus, and finally descends over the posterior part, all the way to the rectum. (*Tr. du Bas Vent.*, n. 599–600.)

221. [*Broad Ligaments.*][1] On the whole of each lateral part or edge of the uterus this portion of the peritoneum forms a broad duplicature, which extends on each side more or less directly to the neighboring lateral parts of the pelvis, forming a kind of membranous septum between the anterior and posterior halves of the cavity of the pelvis. This septum is afterwards continued in a loose manner to the peritoneum, over the sides of the pelvis. These two duplicatures are called the broad ligaments, and also the alæ vespertilionum.[2] The upper edge of each is partly double or folded, forming two small distinct duplicatures, which Winslow calls the leaves or little alæ of the broad ligaments, the anterior leaf being higher than the posterior. The laminæ of all these duplicatures are held together by cellular tissue, in the same manner as the other duplicatures of the peritoneum, and they contain the Fallopian tubes, the ovaries, a part of the spermatic vessels and of the vessels that go to the body of the uterus, also the round ligaments, the nerves, etc. (*Tr. du Bas Vent.*, n. 601–603.)

222. *Bloodvessels.* The bloodvessels[3] of these parts are of many kinds, viz.: the hypogastric arteries and veins, the ramifications of which go mainly to the body of the uterus; the spermatic vessels, so called; and the two vascular cords, commonly called the round ligaments, but better termed the vascular cords of the uterus or of the broad ligaments. The hypogastric branches, arterial and venous, arise on both sides from the artery and vein of the same name, gain the lateral edges of the uterus and are distributed to all the parts thereof, internal and external; they form numerous tortuosities. The arteries of one side communicate with those of the other, and the arterial ramifications form numerous anastomoses with each other. The veins from each side anastomose in the same way. All these vessels communicate likewise with the spermatics, the vascular cords of the broad ligaments, and the hemorrhoidal vessels. These frequent anastomoses are best shown by injection of the hypogastrics. Many of the extremities of these arteries open into the cavity of the uterus. In the veins, there is this peculiarity, that they communicate with the internal hemorrhoidals, and consequently with the portal vein. The spermatic vessels have nearly the same origin, course, and interlacements as in the male sex. They do not pass out of the abdomen, but proceed to the ovaries and the Fallopian tubes, and communicate with the hypogastrics and the vascular cords of the broad ligaments. The spermatic veins are more numerous than the arteries; these vessels also send out lateral ramifications which seem to communicate with the mesaraic veins[1] of the portal vein. The vascular cords, or round ligaments, are two long fascicles of fine arteries and veins bound together by a fine cellular tissue; they glide into the thickness of the great duplicature of the broad ligaments from each angle of the fundus of the uterus as far as the annular openings of the abdominal muscles. Throughout this course each fascicle produces an elevation on the anterior surface of the broad ligament, so that the anterior layer of this ligament bestows upon the vascular fascicle a kind of tunic, and thus makes it seem like a distinct cord bound to the anterior surface of the duplicature. These cords seem to communicate with the spermatic and hypogastric vessels, and they may be regarded as a particular continuation of the spermatics. They then follow a course nearly resembling that of the spermatic vessels in men; they pass out of the pelvis, through the openings of the abdominal muscles, and then proceed to the upper and almost to the middle portion of the alæ or nymphæ, where they are lost in the fat of the groins. It may be conjectured that these vessels furnish matter to the lacunæ, of which hereafter. As they pass out of the abdomen, they are accompanied by a continuation of the cellular tissue of the peritoneum, almost the same as is the case with the spermatic cord in men, and also by a bundle of fleshy fibres resembling a kind of cremaster. (*Tr. du Bas Vent.*, n. 614–622.)

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[1] Plate VII, fig. 1.

[2] Bat's wings, see n. 248, note.

[3] Plate III, fig. 2.

223. The *Nerves* come from the lumbar, sacral, and intercostal nerves, almost the same as in men. The *Lymphatic*

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[1] *i. e.*, the mesenteric veins.

Vessels run chiefly in the tunics continued from the peritoneum. The *Lacteal Ducts*, which are seen at an advanced period of pregnancy, will be described elsewhere, as also the particular fibres, the interlacements of which seem to make the thickness of the uterine walls during pregnancy. The inmost of these fibres, arranged in the manner of a spiral cone, are what make the orbicular muscle of Ruysch. (*Tr. du Bas Vent.*, n. 623.)

224. BOERHAAVE. (*Instit. Med.*) Woman has a broader sacrum than man; it also turns more out; and her coccyx retreats further backwards. Moreover, her ossa innominata are broader, with a greater distance between them, and in their lower part, they extend far more outward. The same is also true of the lower tuberosities of her pubic bones. Hence women, unlike men, are broadest about and within these bones, and the capacity of their pelvis is much greater than in men. Women are also much flatter on the front part of the chest. It has been observed that they perspire much less than men. (n. 659, 660, 662.)

225. In the pelvis is situated the uterus, soft, pulpy, all vascular, readily extensile, not very elastic, almost free, and hardly subject to pressure. It is defended by the expanded membrane of the peritoneum. Its bloodvessels, after forming reticular plexuses which creep through the substance of the uterus, are finally lost. They constitute the chief part of the uterine body. The cavity of the uterus is pierced by many minute orifices from which exudes a bland and aqueo-mucous humor. (n. 663–664.)

226. SCHURIG. (*Muliebria.*) The *Vagina* is contorted, and somewhat oblique and contracted. Except in coition, its sides are somewhat flaccid, and collapse like those of the intestines; but the contrary is the case at the time of menstruation, coition and parturition, when it becomes more ample.—It comes up to meet a short penis, yields before a long one, dilates for a thick one and contracts for a thin. (III, i, § 5, 7.)

227. *Uterus.* In virgins, unless the menses are on, the cervix or neck of the uterus will admit only a rather fine stylet.—It is always closed, particularly after coition and during pregnancy [but in fruitful coition it is always open] (III, ii, § 7, 8). Cases of large uterus from various causes (§ 15). Many instances of double uterus (§ 30). Cartilaginous uterus; scirrhus; stony, callous; spongy; cancerous. Fungi in the uterus; moles; natta.[1] Wind from the uterus. The question whether a flame ever comes from the uterus. [Dropsy of the uterus.] Hydatids in the uterus; [together with a fetus]; calculi; [a hair-pin]; hair [etc.]; worms; ulcers; gangrene (§ 35–52.)[2]

228. Morgagni. (*Advers. Anat.*) In a girl of thirteen, Morgagni found the posterior internal surface, not only of the cervix, but also of the fundus of the uterus, to be divided into two parts by a deep longitudinal furrow.[3] In the last months of gestation, according to De Graaf, the uterus seems almost to put off its membranous substance; for when dissected, it is so red in color, and is seen to be perforated by so many little foramina,—which are nothing else than the ends of the cut vessels,—that it assumes the appearance of a spongy substance. Malpighi [examining the uterus in women who had died either just after childbirth, or about the seventh month of pregnancy] describes its outer substance as made up of fleshy fibres massed together into fascicles and reticularly enmeshed; on the removal of the chorion and placenta, its inner substance was also found to be muscular [composed of plexuses of fleshy fibres]. Morgagni also saw this muscular coat in the case of a woman who had died just after childbirth; and other anatomists have also seen it. Authors state variously that the uterus regains its former size, 8, 10 or 16 days after parturition. In the case of the woman mentioned above, Morgagni found the external vessels of the uterus a finger-breadth in thickness, and he saw sinuses communicating with them, which would admit the little finger in any part; and on the surface of the uterus, where a part of the placenta was still adherent, he found foramina communicating with these sinuses, and of such dimension that the largest of them would by no device give entrance to the tip of the little finger. It is therefore no wonder, he adds, that a liquid or air injected through the arteries in puerperal women should reach the uterus (IV, § 25, 26, p. 46–48).

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[1] Natta (more correctly *nata*)—a fleshy excrescence or tumor having the shape of the natis or buttock.

[2] See further citations from Schurig in Append. n. 10.

[3] Our author here adds "De Graaf has also observed the same thing,"—but this is plainly a mistake. For Morgagni is here quoting De Graaf (*De Mul: Org.* VIII, p. 96) as denying the existence of any longitudinal furrow in the womb. Morgagni himself agrees that *as a general rule*, no such furrow exists, "nevertheless (he adds) in a girl of thirteen years," etc.

229. Morgagni was the first to observe that the rugosities of the cervix are produced by valves, which valves he delineates.[1] There are about fifteen or sixteen of them, more or less, all facing downwards, not upwards [*i. e.* toward the orifice, not toward the uterus]. Arising from the doubling of the inner membrane of the cervix, they are extended transversely or obliquely between the longitudinal fascicles of fibres [in such a way that their upper border (or that nearest the uterus) is firmly attached, but their lower border (or that facing the orifice) is free]. Thus when a probe is introduced and pressed against them, they allow it to pass downwards [*i .e.*, towards the orifice] with no trouble; but when it is forced upward, they entirely prohibit its course. In the hedgehog, the orifice of the uterus is girt up with a ring constructed in the same fashion. In the sheep and cow, the cervix has little valves similar to those described above. The cervix of the uterus, or that tube which extends from the meeting of the cornua all the way to the vagina, rises into numerous and thickly placed folds which run straight upon it longitudinally. These folds are all raised in one particular part, more than in the rest of their extent, so that taken together the elevations present the appearance of a ring. These rings are the less contracted, the further they are from the cornua. Thus, what with these barriers, and with the valves which face downward, it is far easier for a probe to get out of the uterus than to get into it. (I, § 14.)

230. Morgagni has also found a great number of vesicles in the cervix, sometimes also in the orifice, and sometimes in the orifice alone.[2] "I remember (he says), that on pricking these vesicles in an elderly female subject, no mucus came out, but a fluid like that contained in hydatids spirted into the air." (IV, § 39, 40, p. 69–70.) I have certainly always observed that the humor, or rather mucus, that I express from these vesicles in large quantities, is of a sluggish character, and when compared with the liquor of the hydatids which were occasionally found in the vicinity of the testes[1] and the Fallopian tubes, I found it to be of a wholly different character; whilst on the other hand, I uniformly remarked that it has the greatest similarity with the mucus in the cervix, and in the uppermost part of the vagina. (I, § 32. p. 44.)

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[1] The delineation referred to, shows the arbor vitæ or plicæ palmatæ of the cervix with about twenty globules or vesicles (referred to in n. 230) irregularly disposed and of varying size. See Plate V, fig. 3.

[2] Naboth, a contemporary of Morgagni, took these vesicles to be little ovaries, which he compares

231. Ruysch. (*Observ. Anat.*) Description of a fleshy polypus in the uterus; of a scirrhous and malformed uterus which hung outside the pudendum (Obs. 6, 7). The uterus sometimes prolapses so as to extrude from the body. It is sometimes inverted at childbirth;[2] outside childbirth, it is not inverted [even when extruded from the body], but is only prolapsed [so that the internal os[3] shows at the outmost extremity of the prolapsed uterus] (Obs. 9, 10). I regard nothing as more certain than that the uterus performs great movements in childbirth, and that all the natural efforts of parturition depend almost entirely upon the uterus,—[which efforts, after the delivery, are not unfrequently so powerful as to produce inversion of the uterus and its projection from the body]. In other puerperal women a few hours after birth, I have found that the motion of the uterus was so evident, that frequently the nurses, and even the patients, asked me whether there was not another child in the womb. And I myself have placed my hands over the belly, and have found the motion so remarkable that my hands were thrust away just as though by an actual fetus; nay, in some cases the womb rose up, etc. (Obs. 93.)

232. Thom. Bartholin. (*Anatome.*) The uterus is situated

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to fruits on the arbor vitæ of the cervix. They were, therefore, called *ovula*, or *ova Nabothi*. They are now called the cervical glands, or glands of Naboth. See n. 246, note, and Plate V, fig. 3.

[1] *i. e.* the female testes or the ovaries; see n. 233, note.

[2] In the cases here referred to, the uterus was turned completely inside out, and hung outside the pudendum.

[3] See n. 219, note.

between the rectum below and the bladder above; thus we are born between dung and urine. Its length from the pupendum to the end of the fundus is generally about eleven finger-breadths. In the last months of pregnancy, it becomes two finger-breadths thick, and exchanges its membranous substance for a red, fungoid and spongy substance,[1] which is perforated with holes like a pumice stone. Its substance is thickest about the internal orifice, which is narrow. The neck or cervix is attached by its own substance and by the membranes; the fundus is free. The round ligaments pass down through the abdominal rings to the fat and to the membranes of the bones, and are obliterated near the clitoris, to which they are attached and where they degenerate into a broad, fine nervous film (I, c. xxviii). The neck or cervix is a comparatively narrow canal which will admit a good sized stylet. The cornua is the term given by Bartholin to the lateral parts of the fundus where the vasa deferentia are inserted. The orifice of the uterus is oblong, transverse and very narrow; when it opens, it becomes orbicular and round. Within the canal of the orifice and added to its lower part, is found, according to Riolan, an oblong tubercle which closes up the orifice with some exactitude; around which tubercle are seen pores or little foramina which seem to be the extremities of vasa deferentia terminating at the cervix. (I, c. xxix.)

233. [Bartholin defines the vasa deferentia as: 1. In a strict sense, a number of small ducts and vessels, which carry a part of the seed generated in the testes[2] down to the uterus.

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[1] See n. 312, note.

[2] The ovaries. These were formerly called the testes of women, because they were believed to be for the secretion of a female seed, which was to be mixed with male seed for the production of offspring. Hence also the ovarian ligaments were called vasa deferentia, being supposed to carry the female seed from the ovaries to the uterus. This doctrine was propounded by Hippocrates (*De Genitura*) and Galen (*De Semine*); and though opposed by Aristotle (*De Gen. Anim.* lib. I, c. 20), and such famous followers as Averroes and Avicenna, who held that the only female analogue to seed was the menstrual flow, was yet the prevailing doctrine until the middle of the seventeenth century. The enunciation at that time, by Harvey, of the doctrine *omne vivum ex ovo*, led to the gen-

2. In a broad sense, they include also the vasa præparentia.[1] 3. And, in addition, the Fallopian tubes. Taken in a strict sense, they are minute ducts running from the testes, either by a short passage[2] to the fundus of the uterus, or by various little branches to the Fallopian tubes. Galen and others say that they could find no other insertion except that into the uterus; but Zerbus, Fernelius and Laurentius have found another little branch which goes to the cervix,—this part of the vas deferens being longer and finer than the other; it runs along the sides of the uterus and is inserted at the beginning of the cervix below the os. Varolius also mentions this branch, and he asserts that in those who have not conceived, it is so exceedingly small as to be unobservable except by the skilled anatomist, but that in gravid women, it is quite large. Spigelius, being unable to find it considered it a sport of nature. Veslingius seems to admit its existence, since he states that it is by this path that the seminal matter of women is derived from the testes to the fundus and vagina. Thomas Bartholin agrees with Spigelius, because these branches are rarely seen. There are, indeed, always little branches disseminated towards the cervix, but they come directly from the vasa præparentia, and seem to carry blood,—or chyle also,—rather than seed. Respecting these vessels, see Platerus, Riolan, and Caspar Bartholin. The use of these vasa deferentia is to convey the seminal matter partly to the Fallopian tubes to be there perfected and reserved, and partly to the fundus. In cases where there is a branch terminating in the cervix, the seminal humidity is emitted by this path also (1, c. xxvii).] In Bartholin's figure[3] are shown the round ligaments, B. B., the vasa deferentia, E. E., running from the testes to the cornua of the uterus; and lastly a duct, K, rising from the vas deferens and passing to

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eral recognition of the so-called testes as organs for the formation of ova. For some time thereafter they were still called "testes," and "testes or ovaries," but by the beginning of the eighteenth century, the name ovaries was in general use.

[1] The spermatic (ovarian) vessels, called vasa præparentia because they were supposed to *prepare* the female seed.

[2] The ovarian ligament.

[3] See Plate VI, fig. 1, where this figure is reproduced. It is found in the author's *Anatome*, Lugd. B., 1686, p. 173.

the cervix, and into which gravid women are said to ejaculate their seed (p. 272).

233a. [DE GRAAF. (*De Mulierum Organis Generat. Inserv.*) Galen and many of the ancients regarded the short processes between the testes and the fundus of the uterus as vasa deferentia; but others, agreeing with Fernelius and Laurentius, state that from this duct a branch goes off to the cervix,—making the vas deferens, which in the beginning is a single vessel, divide near the uterus into two vasa deferentia, the shorter of which goes to the fundus, and the longer and narrower, running along the side of the uterus between the membranes, terminates at the end of the internal orifice of the uterus, that is, at the beginning of the cervix. By this path, they think that gravid women pour their seed. Highmore and Plazzonus make mention of this duct; and Varolius states that in gravid women it is very large, but in others, is so small as not to be found except by skilled anatomists. Riolan says: "From the lower extremity of the testicle, rises a little vessel, about the length of the little finger, which is inserted in the fundus of the uterus near the insertion of the Fallopian tubes. It is an ejaculatory vessel. Within the tube is contained another little body, nervous, white and somewhat long, which is a continuation of the ejaculatory vessel. In the fundus of the uterus, this vessel is joined with the extremity of the ejaculatory vessel, and the two vessels, thus joined, pour the seed of the testicles into the cavity of the uterus. From their root, moreover, they produce a minute and very slender shoot, which is brought to the cervix by a tortuous course lateral to the uterus." De Graaf adds that accurate examination has not discovered this duct, and he denies its existence (Cap. XIV, p. 220 *seq.*).]

234. SCHURIG. (*Muliebria.*) JOHN ANTHONY VAN LINDEN divides the uterus into os, cervix and fundus.—HIGHMORE observes that the os resembles a glans penis perforated in the middle, except that it is a little blunter at its termination. PALFYN, that in the middle of the neck or cervix is an orifice which is the beginning of a narrow duct which gives passage to whatever has to be expelled; it is always shut except for the transmission of the seed, menstrua, clots and the fetus.

Henry van Sanden, that at other times the cervix will only admit a very thin stylet. [**Dionis**] that the os allows of wonderful expansion, like the gape of a dog or of a tench (III, ii, § 6, 7). **Daniel Hoffman** relates the assertion of a French physician named Gofey, to the effect that the internal orifice of the uterus does not open during coition,—an opinion which Gofey confirmed by digital examination immediately after coition, when he found the orifice tightly closed; but Hoffman refutes him in a few words [showing that his experiment could prove nothing more than that the orifice was closed immediately after coition] (III, ii, § 10). **Veslingius** shows that a particular duct runs from the testes and tubes to the ligamentum teres[1] of the uterus, which descends on both sides from the lateral parts of the fundus towards the lower parts, and perforating the peritoneum and the tendons of the oblique muscles is connected on the pubic bones to the clitoris (III, ii, § 26).

235. Schurig. (*Syllepsilogia.*) **Regner de Graaf** says: Many anatomists, with Harvey, clearly show that during several days after coition, even prolific coition, no seed is found in the cavity of the uterus. Yet the seed must necessarily go somewhere. [In the fundus, however, there are no receptacles capable of receiving so gross a matter as the seed, except the Fallopian tubes. De Graaf, therefore, concludes that the seed passes into these tubes; and he cites] the testimony of Fallopius, who avers that he has often found in the tubes, the most exquisite seed. **Frederick Ruysch** has sometimes found in the uterus and tubes of gravid women, a white seminal liquor, or at least a substance, which, he says, is similar to male seed in color and appearance. **John Maurice Hoffman**, and **John Bohn** doubt whether this is male seed. [Bohn observes that the matter found in the tubes after coition, and which De Graaf puts forth as male seed, has been found by himself in the tubes of women who have never had coition, so that what De Graaf saw cannot be infallibly pronounced as being male seed; especially since] De Graaf himself, forgetting his own hypothesis says that a humor differing from seed sometimes besmears the tubes.[1] GOFEY [according to Daniel Hoffman, denies that the male seed enters the uterus at all].—Hence some have thought that the seed is conveyed [to the ovary, either directly, or through the membranes of the tubes], by the bloodvessels;—or by the pores and burrowing cavities of the membranes; affirming that only the most spirituous part of the seed, the seminal aura and genital spirit, flies thither (I, ii, § 2–4). Some writers say that in the tubes there is an obstructing valve which prevents anything from being conveyed from the uterus to the oviducts.[2] (I, ii, § 8.)[3]

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[1] The round ligament; see n. 248, note.

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[1] De Graaf's words are: As far as I have observed, there is very little liquor found in the tubes, and what there is, has a grosser consistency than the liquor springing from the cervical glands (De Mul. Org. Cap. 13 *ad fin*).

[2] The Fallopian tubes.

[3] For further citations from Schurig, see App. n. 6.

INDUCTION.

236. *If there is anything still doubtful in anatomical physics, it is certainly the mode in which conception takes place, and in which the seed rises up into the ovaries. The general opinion has been, that a kind of genital aura or vital spirit, first inmostly penetrates into either the blood of the uterus, or the membranes and their juices, and by this way flies into the ovaries or small receptacles formed for its reception, and thus impregnates the little ova. Others have held that vermiculi creep through the cervix into the uterus, and from the uterus into the Fallopian tubes and from these, finally, into the ovaries, and thus, after breaking through the little tunics of the latter, worm their way into some particular ovum. At the present time, the common and settled opinion is that the seed penetrates into the uterus, and therefrom, through the Fallopian tubes, into the ovaries. Some anatomists, however, believe that they have found a new ovary in the cervix and orifice of the uterus. Each of these opinions has many experimental proofs on its side; still there are many other experimental proofs that oppose it,—to say nothing of improbabilities, which, apart from the authority of experience, are dissuasive at first sight. Let each one stand, however, by his own opinion, but let him see for himself whether that opinion be consistent* [*with the facts*], *and in agreement with the laws of nature. Since, however, my intention is to draw conclusions from the connection of things, and from rational considerations supported by experience, I wish merely to make passing mention of opposing doctrines, but not to pave the way for the opinion that follows, by any invalidation of other opinions. The very connection* [*of the parts*], *and the naked truth, is sufficient; for it will defend its own cause.*

237. *The passage of the seed through the uterus and Fallopian tubes to the ovaries, labors under the following difficulties:*

[I] *That the glans penis of the male reaches no further than to the internal orifice of the uterus, where we at once meet with a narrow* *little tube, namely, the cervix, which is narrow in itself, and is fenced with divers little rugæ and, as it were, valvulæ conniventes, which hinder entrance into the uterus, but not exit from it.* Respecting these valves, see Morgagni [n. 229], who confirms what we assert by many considerations. Our assertion is also confirmed by the little tube itself, which in the state of contraction will scarcely allow the passage of a stylet; and besides this, the disposition of the fibres and corrugations is such, that when what is called the internal orifice is extended and unfolded by the glans penis, this tube is completely shut; but when, on the other hand, any force, such as the menses, clots, or the fetus, presses upon it from within, it is opened. *On these accounts it is still a question with the learned who have had the best opportunities of experience, whether any seminal humor reaches the uterus itself, or not.* De Graaf says that many anatomists with Harvey, clearly show that during several days after coition, even prolific coition, no seed is found in the cavity of the uterus. But since it is necessary (he adds), that the seed go somewhere, De Graaf finally betakes himself to a passage through the Fallopian tubes[1] [n. 235].

[II.] *And if it did reach the uterus, the point would still be undetermined; for in the uterus are so many open pores and orifices, small and large, and its surface is so evidently cribriform or sievelike, that the uterus itself would everywhere completely absorb this influent humor and its more fluid, spirituous and genital part.* This is supported not only by the very structure of the uterus, but also by reasoning based on this structure, to the effect, namely, that only the purest part,—that which would burst through the little tunics covering the ovum,—expires from the seminal humor. *And the pore that leads into either Fallopian tube at the place of its insertion into the uterus, is so narrow, that it does not seem possible that the seed should choose this way in preference to others that are likewise open; especially in view of the evident fact that a similar con-*

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[1] [Note by the author.] N. B.—Our business here is not to refute, but rather to inquire. We have to discover whether the seed enters the uterus; whether it enters the tubes; or the cavity of the abdomen; whether it is determined to one ovum only; and thus always, *Whether?*

dition obtains here as in the tube of the cervix,—that is to say, that this little orifice into the tube is completely closed as soon as the uterus swells up; nor has it yet been shown, beyond doubt, that any seminal humor has ever been found here. The latter is indeed asserted by De Graaf and Ruysch, but they both say that the tubes were also moistened with a fluid of their own, and that this humor is like the seminal. De Graaf says that a humor different from the seed sometimes besmears the tubes; and Ruysch, that he has sometimes found in the tubes of gravid women, a white seminal liquor, or at least, a substance similar to male seed in color and appearance [n. 235].

[III.] *Again, the seminal substance, having entered the tubes. would, in like manner, fall through the lattice-work of the tubes into their spongy portion. Especially would this be the case with the subtle essence sublimed from the seed, which, were it ever to succeed in reaching the other and larger aperture, would inevitably be diffused over the whole of the subjacent cavity of the abdomen; for however closely the fimbriæ were applied to the ovaries, it seems impossible that they could prevent it, when it got to this field, from making shipwreck in the cavity of the belly.* For the fimbriated extremity of the tubes floats freely in the abdominal cavity,—and this, in order that whatever passes through the tubes may not be determined into the ovaries except in the most general manner, and in order also that these ovaries, like the rest of the abdominal viscera, may be surrounded with fluid,—when yet, in the matters of which we are speaking, nature requires definite determinations.

[IV.] *Furthermore, this seminal aura, or if you prefer, seminal humor, would not only have to break through the general coats of the ovary,—that is to say, through the peritoneum, which being likewise cellular in those parts would disperse the essences of the seed far and wide through its cells,—but would also have to break through the tunicles of the ovum; and not of one alone, but of all, and thus would be carried in, not determinately, but promiscuously; which also would be repugnant to the order of nature, which supposes definite determinations.* For animal nature everywhere forms determinations, and in this way constructs the organism; nay, she constructs simple fibres, as determinations for the very first essence (see above [n. 209]); fibres compounded therefrom, as determinations for the animal spirit; and vessels, as determinations for the blood. That no certain determination should exist for carrying the seed or spirit of the seed described above, would be contrary to order, especially when the matter is one of propagation. That a cellular production of the peritoneum surrounds the ovaries, is a well-known fact.

Moreover, those writers who, directing their minds to both sides of the question, have taken a plain view of these contradictions,—belief in which would almost surpass the faith of miracles,—have chosen rather to betake themselves to an impregnation of the blood or fibrous juice, or to conception in the womb itself, leaving out the Fallopian tubes and ovaries as if they were mere appendages, without any known cause for their existence and use; or to the cervix, where they have set up a new and true ovarium. But we do not tarry over these matters, for it is easy to refute and destroy, but to rear up better structures, and to discover the real truth in this most intricate labyrinth, is a task indeed, and one that requires labor. Opinions are sufficiently refuted and fall to the ground, by the bare setting forth of a truer opinion.

238. *If we duly consider the several connections of the parts and the ducts found therein, it will be clear enough and to spare, that what enters the ovaries, or one of their ova, and commences the work of conception, is not the grosser parts of the seed,—those namely, that are visible to the eye and the microscope,—but its interior, pure, genital, spirituous and vital essence. For this therefore, there ought to exist definite determinations leading directly into some one of the ova and not at the same time into a number. According as is the nature of this primitive or spirituous seed* (genitura), *such certainly must be the nature of the fibrous determinations,—determinations which are not visible to the naked eye, and are hardly visible to the eye armed with the microscope except when they are gathered together in the form of fascicles.* This is the reason why we must proceed with the greater distinctness, and must examine the several parts separately and conjointly; and where experience holds out to us a light or torch, must there tarry; and then, from the connection of causes, and from a comparison with the methods in use elsewhere in the body, and likewise from the correspondence of the organs in the female sex with those in the male, must come the induction and judgment.

239. *To exhibit therefore, a general view of the promotion of the genital seed, the process which is here to be briefly set forth, appears to be as follows: The seminal humor, driven into its first receptacle, that is, into the internal orifice of the uterus, is taken up by that orifice and at the same time by the tube of the cervix; after being taken up, it is shut in, and then, after some delay, is conveyed away through certain ducts into the ligaments of the ovary, called by the old anatomists the vasa deferentia; thence by an uninterrupted path of little canals, it goes to the corpora lutea,*[1] *contorted like little intestines; and from these, by a definite determination, it penetrates, not into the ova, but into some one ovum. Enrooted in this ovum, it then commences the work of formation. When the ovum has expanded to the due size, the common tunic of the ovary is burst through in that place, and the ovum slips into the tube applied to the ovary, and at last is rolled down into the uterus, to which it is attached by means of the placenta, and thus advances into the form of its own species. In this way the several genital organs of the female sex are dedicated to their own peculiar offices. Thus the vagina is for the reception of the penis; the internal orifice for the reception of the glans; this same orifice, and also the narrow passage of the cervix, for the reception of the seed and for its resolution into its purer and essential parts and globules; the ligaments of the ovaries, for its determination; and the corpora lutea together with the ova, for its recèption and insinuation; the Fallopian tubes for the taking up and transmission of the little ovum; and lastly the uterus for the formation of the embryo.* Such[2] seems to be the circle of operations; but to ascertain whether or not it is so in fact, requires a special survey and consideration of the several parts. But I first wish to add some general confirmation drawn from the correspondence of the female organs with the male, and from their co-operation, which is passive and reactive; and thus, in some measure, to establish the statements made above.

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[1] It should be noted that by the term *corpora lutea* (or *yellow colored bodies*) is meant the Graafian follicles, and not the corpora lutea of modern anatomy. See n. 251 a, note.

[2] In the Latin, the rest of the paragraph is printed in italics.

240. *The use of the genital organs of the female sex, besides being gathered from observation and by induction drawn from the connection of the parts, is especially manifest from the correspondence with the organs in the male sex, of which we have already treated. Thus it is evident that the* VAGINA *exactly corresponds to the male penis; and, indeed, in such way, that it completely accommodates itself to the dimensions thereof; in fact, while copulation is going on, it is a kind of outmost tunic to the penis, closely joined with it by a humor that flows between the two. Add to this, that it serves as a cause for exciting the delights of copulation. It is evident also that the* INTERNAL ORIFICE OF THE UTERUS *exactly corresponds to the glans of the penis, to which it completely accommodates itself; so that the last boundary of the copulation is this same orifice. Thus the one operates the active force, the other the passive. In other respects, it plays almost the same part as the vagina. The* FIRST PART OF THE CERVIX, *which is narrow and resembles a kind of tube, corresponds to the male urethra, and into it the male seed is continued. At this threshold therefore, the seed passes over from the man's power into the wife's. The* TUBE OF THE CERVIX, *which immediately succeeds the orifice, corresponds not only to the prostates in man, but also to the vesiculæ seminales; for this tube mingles with the injected seed a particular humor which is squeezed out from its little mouths and vesicles; and what the humor of the prostate has united, this humor again resolves and dissipates. It thus enables the seminal humor to stand forth naked, such as it was in the vesiculæ seminales; for what has been put together in the man, is in the woman to be again resolved into its principles, in order that the genuine spirituous seed may finally pass over into the chamber of the testes.*[1] *The order observed in the one sex is ever similar to that observed in the other; for in what order the seed is put together, in that same order is it separated and resolved into its first essence. There is a* SMALL VAS DEFERENS *or* DUCT, *not observed by all anatomists, which runs within the common tunic*[2] *from the tube of the cervix directly to the ligaments of the ovaries. This vessel or duct corresponds to the vas deferens in man; for it leads the purified serum of the seed all the way to*

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[1] *i. e.* the ovaries, see n. 233, note.

[2] The broad ligament.

the first part of the ovaries by distinct little channels. In the place where this duct terminates in the part of the ovary nearest the uterus,[1] *we meet with a kind of second vesiculæ seminales, wherein the seed appears to be still further purged, and where it is reduced to its first and genuine essence such as it was in the epididymides. From here it continues its onward course toward the ovaries, and therefore, by the old anatomists, this ligament was called the vas deferens. Thus the duct from the cervix to this ligament and thence to the ovary, corresponds to the vas deferens in man. Under the ova are the* CORPORA LUTEA[2] CONTORTED *like little intestines, and which answer to the epididymides or parastatæ in men, to which indeed, they are not unlike in figure and contortion. Moreover, the spermatic vessels which go to the ovary and Fallopian tube, supply not only the ova, but also and particularly these yellow-colored corpora. For in them is received a like essence* [*as that found in the epididymides*]*; that is to say, the sperm, now reduced to its purer globules and consequently so prepared that, from the corpora lutea, it can enter the ova in suitable fashion. Thus they are placed at farthest distance from the other organs; and they are ends, since in the ova are beginnings. Thus they* [that is, the corpora lutea and the epididymides or parastatæ], *mutually correspond to each other in every way. Lastly, come the* OVA, *of which the corpora lutea are appendages, and which therefore correspond to the testicles, in that, what is elaborated in the testicles is deposited in the ova as in its receptacles. Thus the testicles at one end, correspond to the ova at the other, like active force to passive, or efficient force to recipient. Up to this point there is a continual correspondence between the organs of the female sex and those of the male; but here the correspondence stops, and with it the connection also, and the direct communication. The parts that now follow, such as the Fallopian tubes and uterus, are organs and viscera proper to the female. These now take up the work, and continue the web of conception, even to the formation. First, then, of the viscera proper to the female, comes the* FALLOPIAN TUBE, *which by the embrace of its fimbriæ,*

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[1] What is meant, is the ovarian ligament.

[2] *Corpora lutei coloris* (bodies of a yellow color). The words *corpora lutea*, mean literally, yellow bodies. As to what are meant by these corpora, see n. 251a, note.

takes up in its little mouth the ovule torn away from the testes, and by a writhing circumflexion, rolls it down finally into the uterus. Lastly comes the UTERUS, *which is thus entirely devoted to receiving, not the seed, but the ovule, and to growing and forming the embryo. Hence it is apparent that the several genital organs of women are dedicated to their own proper offices; and that they correspond to the organs existing in men; and thus that the animal seed, from its beginnings to the end, accomplishes an entire circle which may be called the circle of conception and generation.* But to render the truth clear, it is necessary that we treat of the several parts; that is to say, of the vagina, the internal orifice of the uterus, the cervix, the ovarian and round ligaments, the ovaries, the Fallopian tubes, and lastly of the uterus itself.

241. *First, then, comes the vagina, which is the path of introduction, and the threshold stretching towards the uterus. Its true office is to receive the virile member and convey it towards the internal orifice. Its second office is to pour on a glutinous humor, to the end that there may be an effort to a real union. Its third office is to excite the pleasure and desire of venery, both in the male and in his virgin partner.* These three offices are concurrent; for they are no more separated from each other than substances from accidents, forms from qualities, and essential causes from impulsive. The first offices produce union, while the latter excite or stimulate it; the efficient cause, therefore, is reciprocal in both sexes. [FIRST.] *The vagina applies itself completely to the male organ as coat to body. For it is so contrived as to allow itself to be expanded and constricted; thus it tightly grasps the virile member, applying itself not only to the breadth of this member, but also to its length.* Internally, it is beset with rugæ or wrinkles, like the valvulæ conniventes in the jejunum[1] whose law it is that they are obliterated when the jejunum is expanded; see above;[2]. For the folds arising from the tunics are not entirely circular, but are interrupted,—the longitudinal folds serving them as a basis. They are therefore naturally obliterated when the vagina is expanded. In virgins, thus in subjects where the vagina is comparatively narrow, these wrinkles are of larger size. *This disposition of the vagina appears to have the effect that the narrower it is, the longer it is; but on the other hand, the ampler it is, the shorter it is; for the arrangement of the folds and also actual observation, prove that such is the case. Furthermore, in the venereal heat the vagina is in the effort to expand, and, indeed, to come up nearer to the male organ, and almost to go to meet it.* In virgins who have not yet experienced venery, the corrugation of the vagina is more considerable, and its length greater, but its calibre less; in other women the contrary is the case. That the vagina is accommodated for the reception of the penis is evident, not only from its extension and broadening, as already noticed, but also from its actual measurement which is six or seven finger-breadths. *In coition, therefore, it constitutes, as it were, the outmost coat of the penis, just as though it aspired to be of one body with the latter; for such is its state, that it applies itself wholly and completely.* If the penis were environed by an additional coat, such coat would be no other than one like the vagina; and therefore, the latter has received the name, vagina, or sheath. For it is not only the folds that contribute to the application of the vagina, but also the rest of its substance which is of a robust nature; and, moreover, the substance at its entrance or beginning, which internally is spongy, and externally cavernous. For the entrance is softer than the passage, in order that after a comparatively easy entrance, it shall be necessary to attack the rest of the passage with some little force.

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[1] The valvulæ conniventes (self-closing valves), of the jejunum, are circular or spiral folds of the mucous membrane of the jejunal portion of the intestinal canal. Swedenborg gives their use as being to continue the detrusive force of the stomach, their action being like that of a screw, which pushes in the direction of its spiral.

[2] See n. 14, note. The ECONOMY OF THE ANIMAL KINGDOM does not treat of the abdominal viscera. The reference is probably to the ANIMAL KINGDOM; see 1 A. K., n. 136.

242. [SECOND.] *Moreover, a glutinous humor is expressed, which stops up the interstices of the rugæ and essays to produce a kind of real unition; but it is provided that the two bodies shall be one, only in the act itself.* See above [n. 209]. It is well known that a viscid and glutinous humor oozes from the vagina; that is to say, that thick-set crowds of pores and little orifices perforate the internal coat,—as is evident merely from squeezing the vagina; see also the observations on the subject by Morgagni [n. 204], Heister [n. 180, 215], Winslow [n. 113], and other practical anatomists. And since this peculiar glue oozes from these ducts and orifices; and an additional supply comes from the ducts belonging to the internal orifice of the uterus, being increased moreover by the non-seminal humor expressed from the male urethra and superficially accompanying the seed,—which part flows back from the internal orifice; and since, nevertheless, interstices remain between the rugæ and at the same time on all sides where there is any fissure to be seen; it follows, not only that the several spaces are filled in, but also that this humor endeavors to, as it were, glue the one to the other,—which, however, cannot be actually effected inasmuch as the act is short, and is combined with reciprocal and local motion. Moreover, the gluey powers of this humor are also proved by its viscid essence. *Thus adequate provision is made that, at the time of coition, nothing shall enter the orifice and duct of the cervix, except the male seed; and least of all, any air—air being hostile to generation and to the operation of the seed.* As will be shown below. Nothing is more hostile to the womb than air, which disturbs the whole work of conception and formation. For air is the force of nature's activity in ultimates, having hardly any laws except those of the most general sort; and hence, animal nature would never be able to weave any organic web unless the air were first shut out. The ether, however, is admitted, for it is of a more perfect nature.

243. [THIRD.] *Moreover, by this contact and impletion, the vagina instigates to the venereal ardor, not only the male organ, but also the subjacent spouse herself.* For the vagina is not merely nervous, but is also papillary. It is the nervous coat, which is the inmost, that makes the rugæ or wrinkles; and consequently this coat, when touched, produces a general sensation, but the papillæ, a sensation that is more distinct and individual. Thus when the male organ is moving to and fro, and the interjacent humor is vibrating the several fibrils or papillæ, there must necessarily be set up a tacit titillation,—a titillation which must equal the sum [of the fibrils], and which may be reduced to calculation. The papillæ are the more sensitive in proportion as they are more naked, and the rugæ more unfolded. *In men only the glans*

penis is sensitive in the way in which the whole of the vagina is sensitive in women. The more, therefore, the male glans is bathed about with bland enticements and touches, that is to say, the more of such allurement is put in its way, the more pleasurably is it affected; which happens immediately on its entrance into the external orifice of the vagina, and, in the underflowered virgin, continues throughout its whole progress to the internal orifice; but afterwards, only in the internal orifice,—if the penis gets so far. Add to this, that, by the retraction of the prepuce, the frenum raises the venereal heat to the highest pitch,—the retraction exciting the whole of the tendinous, aponeurotic, and nervous tunic, so that it still more powerfully contracts the penis; while the fancy and imagination of the mutual venery comes now into play, and excites the animus itself to the utmost degree of ardor. The glans, and particularly its corona where the prepuce terminates, is papillary and very sensitive; see above [n. 135, 149 *fin.*]. When therefore, like a blunt wedge, it enters the vagina, the above part of it is affected to the last degree by contact with the folds and soft unevennesses which it meets. The prepuce also is somewhat papillary, and, when laid back, it too is sensible of the same delights; but these delights, because they probably penetrate to the cerebellum, are perceived as general delights, but not as distinct and particular delights. All this sensation is concentrated as it were upon the frenum turned back under the urethra; and the frenum thus communicates it to the inner surface of the urethra and at the same time to the outer tunics of the corpora cavernosa or penis; [the latter] is then compelled to a peculiar constriction, so that the muscular and aponeurotic tunics more powerfully react against the active forces within; see above [n. 148]; and therefore more juice is expressed from the male urethra. *The greater the reaction, the greater the stimulation. For the tunic of the penis is reactive, and limits the extension of the corpora cavernosa; and hence a greater quantity of the venereal juice is extruded from the urethra, and also from the prostates and vesiculæ seminales. This is the reason why the virgin vagina naturally brings more delights than the ample vagina of women already deflowered; and indeed, the greatest delights of all in the first flower, when the tunic still obstructs the way, and, when it has been broken through, affords a passage into* *the constricted vagina.* Besides the cause already adduced, namely, the kindling of the animus by the imagination of the mutual venery, the constricted measure of the vagina also, and the continuous touch of all the parts, contributes actually to this affection of the body. The hymen is, in fact, nothing but an obstacle, and [its breaking constitutes] a fracture of the first defending wall. Nevertheless, at this time, it is nothing but fancy that kindles all this ardor; for the violent contact contributes nothing, but rather extinguishes the ardor. But while the fancy labors with hope, and when at last the vagina is gained, then comes increase from a bodily cause also, which augments and completes the work. This is the reason why we have the utmost love for her we have deflowered, and why we prefer the hymen above other delights.

244. *With regard to the hymen, it is the septum which bounds off the male organs from the female. It is placed in front of the external orifice of the vagina, and at the same time constricts this first threshold; and so long as it remains entire, entrance to that sacred court is forbidden. This gate is shut until the period of puberty, in order that meanwhile, the internal genital organs may come to maturity and may not be infested by anything injurious, nor indeed, by the external air. For the same is the case here, as in men; namely, that the genital organs are not perfected and inaugurated into their uses, until the spirit and blood run over with superfluity and no longer require to be spent upon the growth of the body. When the spirit is thus superabundant so that it can be expended without loss to growth and increment, it is then naturally derived hither for discharge. This is the reason why, at that period, the menses first begin to flow.* Thus in these respects, there is a correspondence between women and men. The superfluity itself produces the urgent desire for venery, this superfluity is derived, not only into the vagina and the glands with which the vagina is beset, but also into the several vessels both of the ovary and of the uterus (of which subject we shall speak presently), so as to meet the superfluous part of the male. The organs themselves grow and increase together with this material,—organs being nothing else but instruments of fluid agents; thus the one is accommodated to the other. But we will now pass on to the rest of the subject.

245. *The internal orifice of the uterus comes on just where the vagina terminates, and indeed is so constructed, that it can be expanded and fitly constricted, and can exactly adapt itself to the glans penis. This orifice, therefore, seems to be formed for the reception of the glans, while the vagina is formed for the reception of the remaining part of the body or penis.* This is confirmed by the anatomists. For though in virgins the internal orifice is quite contracted, yet, while being expanded and during its expansion, it exactly corresponds to the glans penis. Here therefore is the last terminus whither the penis penetrates the belly. This orifice is confounded by many with the tube of the cervix, and hence it is often denominated the neck of the cervix. At any rate a small narrow foramen opens from it to the cervix, or tube of the cervix, so that the glans penis cannot be pushed on any farther; for it can by no means open this foramen, which is continued to the cervix. This orifice is likened to the gape of a dog, to the mouth of a tench, and to the cœcal intestine. *This orifice not only adapts itself to the intruded glans, but it is also bathed about by the same kind of humor as the vagina, and moreover, by the seminal humor of the man; so that all passage into the tube of the cervix is precluded save for the male seed.* Observers have also detected numbers of glands in this situation, and also a native humor, as in the vagina. Moreover, the humor that oozes from the male urethra and occupies the circumference of the seminal torrent, also, in part, remains here and bathes the penis, and is carried out on its withdrawal. *This orifice likewise excites venereal desire, both in the male and in the female; for they are so fitted together that the universal papillary structure on the male glans is in a state of contact, and, moreover, the frenum, quite drawn back, and the prepuce lie in the vagina.* These points are similar to those mentioned above with respect to the vagina; for the manner of the matter is the same in both cases, except that this orifice encompasses the glans more strictly, and touches its every point.

246. *With regard to the cervix, this comes on immediately after the orifice and is its first boundary,—a kind of narrow duct which admits no part of the glans penis. It has a foramen opening from the internal orifice, described above, which exactly applies* *itself to the orifice of the male urethra. We find here, therefore, a continuation of the male urethra, consequently a continuation of the seminal torrent which is poured directly into this duct from which there is no open entrance into the uterus.* The reader will find this duct delineated and its dimensions given by De Graaf, Morgagni, and other anatomists. It is a kind of tube, so narrow that when contracted it will scarcely afford passage to a stylet; see the anatomists. [n. 232–234.] Moreover, it is all full of folds, and indeed of valves, so disposed as to allow no passage inwards, but a free passage outwards, for example, for the menses, uterine masses, and the child; see Morgagni [n. 229], and the other anatomists. Nay, its fibres are so arranged that when the orifice is forcibly drawn open from without, this duct is more straitly closed, except for the fine aperture leading from the orifice to which the [male] urethra is applied. Therefore, it cannot be gainsaid that it is a receptacle for the seed, and at the same time a barrier to prevent the seminal humor from penetrating farther. *Wherefore this first entrance to the uterus is the first receptacle of the seed such as it is when emitted from the vesiculæ seminales and prostate glands; at the same time it is a barrier to prevent the seed from going any farther, that is, into the uterus.* For up to this point, the male urethra is continued, to which, as being the continuation of its channel, the cervix corresponds,—into which the seed is ejaculated. This is evident from the mere connection of the parts. This is the seed that comes from the vesiculæ seminales and prostate glands; and therefore to these organs the cervix corresponds. *Therefore, this first part of the cervix represents the vesiculæ seminales in men. And because it has this correspondence, and because, in men, the seed is heaped together in these vesiculæ and is again joined and as it were glued together by the humor of the prostates, so in this place it must be again resolved into its principles. First, then, it is here separated from the humor of the prostates.* And this indeed, principally by the throwing on of a comparatively thin or aqueo-serous humor that resolves this somewhat gross matter. See Morgagni [n. 255] and Boerhaave [n. 225]. Respecting the glands and quasi hydatids met with in this situation, see our authors, all of whom agree in affirming that numbers of these glands are discernible. This humor, which comes from the male prostates, appears to fall back into the subjacent orifice and vagina, the passage to which is open and leads downwards; and it would even seem to be sometimes absorbed here by the veins. A humor of this kind has been observed to run out after the lapse of several days. *After this humor has passed away, there remains the true seminal humor like what is wont to lodge in the vesiculæ seminales of men,—and this between folds that represent gyres and convolutions such as are found in the vesiculæ seminales.* This is also the reason why some anatomists, particularly the older ones, called this part of the cervix the vesicula seminalis of women, and wished to set up here a new ovary[1] [n. 218]; why also, they imagined that here the female seed came to meet the male seed, to which female seed therefore they also attributed a plastic force. Yet nothing more is found here than a liquid of slight density which resolves and dissipates from the seed those parts that have been thrown on by the prostate glands. In order that the seed may be fruitful, it is necessary for it to return to its first globules or spirituous substances, and the return first begins here; for here the seed lies enclosed, here it tarries, is rolled about among the folds, and so by degrees shakes off all that has been added to it.

247. *From this part of the cervix runs a certain filamentary and fibrous duct which terminates in the ligament of the ovary close under the insertion of the round ligament or ligamentum teres of the uterus. Since this duct is plainly visible[2] under the general tunic, that is, the tunic formed by the peritoneum, and since it is extended all the way to the beginning of the ovary, we may conclude*

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[1] See n. 233 and 233a. The vesicles found in the cervix were called vesiculæ seminales, by Blegny (1680) and also by Desnoues, Naboth, and Hoffman. In a disputation, *De Sterilitate*, given in 1707, Martin Naboth, Professor of Anatomy at Leipsic, set up the doctrine that the vesicles of the cervix are genuine ova, (see n. 230, note); and that the cervix itself is the true ovary, and not the testes as had been held. Surprising to say, this remarkable doctrine was defended by the celebrated professor Frederick Hoffman of Halle; but it was severely condemned by Ruysch, Goelicke, and other eminent anatomists. The theory created some stir, but was soon forgotten.

[2] The Latin is, *hic ductus quia manifeste apparet sub* etc., which Dr. Wilkinson translates, "As this

that the seed thus purged from accessories, follows this path through peculiar ducts. This duct, therefore, represents the first part of the vas deferens. There are but few anatomists who have observed this duct; or probably the majority have not regarded it as of sufficient importance to merit a careful investigation and description at their hands. It has, however, been described by Riolan [n. 233a], and after him by Bartholin [n. 233], who has also delineated it in his plates. He mentions an oblong tubercle within the canal of the orifice and appended to its lower part, which closes up the orifice with some exactness; around this tubercle are pores or little foramina, which, he says, seem to be the extremities of vasa deferentia terminating at the cervix. In the description of his figure,[1] he says that K is a duct rising from the vas deferens and passing to the cervix, and into which gravid women are said to ejaculate their seed. In common with the old anatomists, Bartholin gives the name "vasa deferentia" to the extremities of the ovaries which are inserted in the uterus, and respecting which we shall speak presently. In order then not to break the thread of the present treatise, it will be necessary for me to betake myself from the present discussion to a description of the ovaries, that thus I may complete the whole circle; for the uterus comes last, since it is the end, and as it were the center of all the operations. Afterwards, when I have come to the uterus, I shall again take up and continue the thread now abandoned, and shall discuss the use of that organ itself. In the meantime, the reader should carefully keep in mind the remarks made above respecting the uterus, its ligaments and spermatic vessels. The series is an entire one, and unless I follow it strictly the way will easily be lost.

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duct plainly opens under," apparently regarding *apparet* as a misreading for *aperit;* but the original manuscript plainly reads *apparet.*

[1] See Plate VI, fig. 1, where this figure is reproduced.

CHAPTER XII

THE OVARIES.

248. HEISTER. (*Compend. Anat.*) The ovaries, formerly called the female testes, are two bodies, somewhat globular, smooth and white, and attached to the fundus of the uterus on either side.[1] Each is connected: 1. With the fundus of the uterus by means of the ligamentum teres, called by the ancients the vas deferens of women, but which has no passage to the uterus. 2. With the Fallopian tube and the sides of the pelvis, by the broad ligaments and the alæ vespertilionum. 3. With various other parts, by means of the spermatic vessels. In shape, they are ovoid, gibbous above and smooth below. Their size varies according to age and temperament; they are largest in the prime of life and in libidinous people, and are frequently furnished with prominent vesicles; but in old women they are dried up, small, wrinkled, and pitted with cicatrices. The alæ vespertilionum[2] are membranes lying between the ovaries and the Fallopian tubes. The ovaries are encompassed by a strong white membrane derived from the peritoneum. In substance, they are membranous, fibrous, reticulated, and interwoven with great numbers of vessels among which are frequently seen round vesicles varying in number according to age and temperament, and filled with a humor similar to the white of egg. When boiled, this humor obtains also the consistency, color, and taste of white of egg. It was because of this analogy with eggs, that these vesicles were called, first by Steno, ovules or little eggs; the largest of them is hardly as big as a pea. Sometimes there are ten, fifteen, twenty, or even more ovules in one ovary; sometimes there are only one or two. They are believed to contain the first rudiments of the fetus. Hydatids also are often found in the same situation; these however are morbid, and are frequently the cause of ovarian dropsy. The corpora lutea[1] are a kind of glandular substance of a yellowish color contorted like delicate little intestines; they lie under the ovules which are set in their substance, and are visible in virgins, but most especially in pregnant and child-bearing women. (n. 237.)

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[1] See Plates VI, fig. 2; V, fig. 1; VII, fig. 1.

[2] The term alæ vespertilionum (bats' wings), was used generally to designate the broad ligaments (n. 221); but more particularly, as in the present case, to designate that part of the broad ligament which lies between the ovarian ligament and the Fallopian tube, and which was called by Winslow, the "little ala" (n. 221).

249. WINSLOW. (*Expos. Anat.*) The ovaries are two whitish, oval, flat, oblong bodies. They are attached to the uterus by a kind of ligament, round and short, together with which ligament they are enclosed in a duplicature of the posterior leaf or ala of the broad ligament. They are composed of a very compact spongy substance, and of several transparent vesicles called ova. The spongy tissue surrounds each of these vesicles very closely, and seems to furnish them with distinct spongy coverings or calices. These vesicles must be carefully distinguished from certain abnormal vesicles termed hydatids. The ligaments of the ovaries are enclosed in the edges of the posterior wings or leaves of the broad ligaments, much in the same manner as the umbilical vein lies in the edge of the anterior or umbilical ligament of the liver. They are round cords of a filamentary texture, attached by one extremity to the fundus of the uterus a little above and behind the level of that fundus. They were formerly believed to be hollow, and were regarded as vasa deferentia. (*Tr. du Bas Vent.*, n. 604–606.)

250. BOERHAAVE. (*Instit. Med.*) The ovaries are two scabrous bodies of uneven surface, spheroidal in figure, and enclosed in a firm membrane. They are irrigated by the spermatic, hypogastric and other arteries, all of which are so closely united before they enter that they seem to constitute a single vessel woven into reticular plexuses. The same is true of the veins and lymphatic vessels. All the vessels are so mingled and interwoven with nerves to make up the structure of the ovary that the resulting fabric hardly admits of description. On the surface of the ovaries, under the investing membrane, are found certain spherules attached below by a thickish calyx to the substance of the ovaries. They are pellucid, filled with a lymphatic fluid, and consist of two concentric membranes connected together in the closest manner. The ovaries are small at first, and gradually increasing, come to their largest size at the period of prolification [after which they diminish]. After the exercise of venery, the little bullæ [or spherules] mentioned above, gradually swell, little by little, become more pellucid, thicken in their membranes, raise the membrane of the ovaries, stretch it, and so dilate it that they bulge out from the surface like a papilla or nipple. They hang from their peduncles; are separated therefrom; leave a hollow cicatrix in the substance and torn membrane of the ovaries, which gradually coalesces; and finally in these little bullæ, while still adherent to the ovary,[1] fetuses have been observed. (n. 669.)

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[1] See n. 251 a, note

251. MORGAGNI. (*Advers. Anat.*) [Malpighi, from his observations of the corpora lutea and of the ovules enclosed therein, teaches that these larger vesicles of the ovaries are not truly ova, but are the material from which is originated the glandular corpus luteum by which the ovule is separated, cherished, and in due time ejected. De Graaf seems to be of the same opinion; for though he calls these vesicles ova, yet later on] he teaches that shortly after coition a peculiar glandular material grows between the membranes of the ovum, enveloping the whole ovum and presenting the appearance of a globule; and in his last chapter he affirms that ova ten times smaller than before coition are expelled from this globule (that is, from the corpus luteum) into the tube. (IV, § 28, p. 51.)

251a. [DE GRAAF. (*De Mulierum Organis Generat. Inserv.*) The inner substance of the testes is composed of membranes and fibrils loosely interwoven, in the interstices of which are found a number of bodies both natural and abnormal. The abnormal are hydatids. The natural are vesicles full of liquor, nerves, and the vasa preparentia [spermatic vessels] which creep through the whole of the ovarian substance, and entering the vesicles, are lost in their tunics. The vesicles and their contents are the sole objects for which the nerves, vessels, integuments and the other parts of the testes exist. Fallopius notes these vesicles as being swollen with a watery humor, sometimes yellowish and sometimes transparent. Horne prefers to call them ova, a name which De Graaf accepts because of the exact similarity of these vesicles to the eggs found in the ovaries of birds; for even in their young stage they contain a liquor like the white of egg, and which when boiled acquires the color, taste and consistency of white of egg. In addition to these large ova, there are also found smaller ones, some being so small as to be hardly visible. Growth in years, and also coition, effects a great change in these ova. In young animals they are very small, but grow larger in older animals. After coition they are so changed that they appear like globules. When they have attained their natural size, they are invested with various tunics or follicles, between which, immediately after coition, grows that glandular substance of which the above mentioned globules are composed (Cap. XII, p. 176, *seq.*). The bodies found in the ovary must not be taken to be perfect ova, but only the rudiments of ova (Cap. XIII, p. 208)].[1]

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[1] Boerhaave subsequently teaches that these little bullæ are the ova that are discharged into the Fallopian tubes. (*Inst. Med.*, n. 670.)

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[1] It should be borne in mind that the term *corpus luteum* as used here and throughout the present work designates the ovarian vesicle containing the matured ovum. This is now called the *Graafian follicle*, the term *corpus luteum* being confined to the Graafian follicle after the discharge of the ovum. According to modern research the ovary contains several thousand microscopic vesicles called primordial follicles. At puberty, from twelve to thirty, of these follicles enlarge to various sizes and become vesicles containing a slightly yellowish humor in which is the growing ovum. These maturing follicles, now called *Graafian follicles* after the distinguished Dutch anatomist who first described and delineated them, occupy the deeper part of the ovary towards its centre or medulla; but the increased size of the ripe follicle occupies the whole space between the medulla and the surface, producing on the latter a rounded elevation or bulge. During the process of maturation, the follicle develops an external fibrous capsule (the *theca*), the delicate inner tunic of which (*the membrana propria*) covers a layer of glandular substance (the *stratum glandulosum*, mentioned by De Graaf, n. 251a). At a certain place this glandular substance projects into the cavity of the follicle, forming a kind of stalk, or peduncle, the head of which (the *discus proligerus* or zona radiata) completely encloses the ovum. This stalk seems to be what is described by Boerhaave as "the peduncle of the

252. Schurig. (*Muliebria.*) Cases of large ovaries, some as big as a child's head, some the size of a fist; the enlargement being due to ascites[1] and dropsy.—Calculi in the ovary;—hairs.—Suppuration of the ovary.—Absence of the ovaries. (III, iii, § 8–12.) In oviparous creatures there is only one ovary, in viviparous there are two. In the ovipara the ova are not contained in one common membrane, but are heaped together into a kind of cluster [but in the vivipara, and in

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little bulla" or ovum (n. 250), and what our author refers to as the "peduncle" and "radicle" by which the ovum is primitively nourished, (n. 273), and the "petiole" which he calls the primitive umbilical cord (n. 302). On the completion of maturation, the follicle is ruptured at the place where it distends the outer surface of the ovary, and the ovum, together with the discus proligerus, is discharged into the Fallopian tube. The empty follicle, now become the *corpus luteum* of modern anatomy, then undergoes certain changes, and diminishes in size until it finally remains only as a scar or cicatrix in the ovary; see n. 250 *fin.* and Plate V, fig. 1. The maturing and matured vesicles (now called Graafian follicles) are identical with the "vesicles" of Heister, who observed from ten to twenty of them in each ovary (n. 248); with the "vesicles or ova" of Winslow (n. 249); the "spherules" of Boerhaave (n. 250); and the "vesicles," "globules," and "ova" of De Graaf (n. 251a), who also calls them "follicles" (*De Mul. Org.* cap. XVI). They are also identical with the "glandular bodies" or "corpora lutea" of Malpighi, Morgagni (n. 251), and Heister (n. 248); these authors, however, and especially Heister, seem to use the term in a more exact sense as designating only the "glandular substance (including the discus proligerus) of a yellowish color, contorted like the most delicate little intestines, and lying under the ovules which are contained in their bosom" (n. 248). In the same sense also seems to be our author's use of the term *corpus luteum*. The term itself ("yellow body") seems to have been used as a description rather than as a technical term; for no mention is made of it in Hühner's Medical Lexicon of 1727, nor in Blancard's *Lexicon Medicum*, edition of 1746; it occurs however in the edition of 1777, where it is given its modern signification,—a signification wholly unknown to the authors quoted in the text; indeed these authors had no specific name to designate the empty follicle, and where they mention it, it is rather in terms of description than of technique. Thus Boerhaave calls it a "cicatrix in the ovary" (n. 250); De Graaf, the "calix" or cup (*De Mul. Org.* Cap. XIII), the "empty globule," and "empty follicle" (*ib.* cap. XVI); and Ruysch, the "calix," "vestige" (*Ad. Anat.* III § 4) and "outer covering" (*Thes.* VI, § 32).

[1] Dropsy of the peritoneum.

women, the ova not only have each its own membrane, but they are also contained in a common membrane].—The ova have a cicatricula [adherent to the vitellus or yolk, and in which is contained the whole of the genital plasma. It is for the nourishing and enlarging of this cicatricula that the vitellus is produced and the albumen superinduced over it. In women the spermatic vesicle involves nothing more or less than the contents of the cicatricula, and] the whole vesicle deserves to be called a cicatricula. (III, iii, § 17–18.)

INDUCTION.

253. *The genuine seed, such as it is when elaborated in the vesiculæ seminales of men, and when purged in the tube of the cervix from the humor of the prostates, rises at once through a kind of vas deferens all the way to the ovarian ligament,—that is, to the cord which the old writers denominated the vas deferens carrying the female seed.* The first portion of this vas deferens, running from the cervix to the thin part of the ovary, may be seen in Thomas Bartholin's *Anatome*. table XLVI, fig. 2, where it is marked by the letters KK, and the place of its insertion by the letter E [see Plate VI, fig. 1]. The insertion of the vas deferens into the ovary may be seen in the same table, fig 1, HH.[1] *But since anatomists make little or no mention of the place of insertion of this first vas deferens into the other, we cannot do more than conjecture that here also this masculine seed contrives to make a little delay, and purges itself of the remainder of that matter or body wherein the genuine spermatic globules are environed, reduced to their forms, defended from injury, and thus prepared for use. Ground for such suspicion is given in the fact that there is here an oblique anastomosis; and at the same place a duplicature of the broad ligament, and a coalition of this vas deferens with the round ligament, which latter consists of a spongy substance, and was therefore thought by the ancients to be hollow. Whether in this place there be any space for the reception of this seed and for further purging it of its matter can hardly as yet be affirmed, except as a probability. Add to this, that the part which is secreted and cleared away from the true testicular seed can here at once be sent away through the round ligaments, and so be despatched to the region of the vulva and at the same time to the fat of the pubes. The connection of the parts argues thus much, as likewise the vicinity of the round ligaments, the fact of their fold-*

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[1] This is a figure showing the ovarian ligament running from the uterus to the ovary, see Plate VII, fig. 1.

ing, their spongy nature, their defluxion to the groin, and their evacuation there; perhaps also some lacunæ devoted to evacuation may be seated about the clitoris. Where experience is lacking, judgment must be made from the connection of the parts. For the rest, time will show whether this judgment is confirmed by experience. Certain it is that these round ligaments are spongy, and are finally inserted in the pubic bone under the clitoris, and that they can thus take up all that recrementitious portion which the other parts,—both those of the ovary and those of the purified seed,—throw off. The case here is similar to what occurs in the vegetable kingdom, in that fruits of all kinds, after falling into the ground which is their womb, are first freed by maceration from all adscititious materials. In the present case, however, the freeing is effected by diremption or taking apart. Now since there are two vasa deferentia [the vas deferens of the male, and that of the female], so also there are two spermatic vessels, the one being the continuation of the other. The one spermatic vessel is that which is applied to the testicles, and the other is the round ligament, which, like the spermatic vessel of men, is continued through the muscles of the abdomen to the outside of the belly. Thus here also we find an analogy and correspondence [between the male organs and the female].

254. *The sperm thus denuded, that is to say, separated into its primitive globules, is conveyed onward through the filamentary cord, which at the present day is termed the ovarian ligament, but which was called by the ancients, the vas deferens of women. This ligament is composed of longitudinal threads, and is a bundle of ducts, such as is exactly suited for the determination and transmission of an essence of this nature.* This is evident from the mere description of these ligaments, see Winslow n. 249. Nor do we need to ask for any cavity here, any more than in the least channelets of the fibres. They are therefore determinations of a pure and subtle essence.

255. *Finally, this seminal material, thus purged, is carried off to its determined ova, or to its own little ovule, and indeed to the corpora lutea, which lie like calices or cups under the ovules or vesicles, and receive this pure seed very much like the epididymides or parastatæ about the testicles of men. To these therefore they* *exactly correspond, being contorted in almost the same way, and in the same way causing this seed to circulate through their little valves. This is evident, not only from the connection of the parts, but also from actual experience in pregnant women; for in the first days of pregnancy these corpora lutea swell up and almost surround the enclosed ovule, cherishing and embracing it on every side; thus applying and forwarding this spirituous stranger and genital guest at every point.* On these subjects see De Graaf [n. 251, 251a], and the other anatomists; see also the description of these corpora lutea [n. 248]. *Add to this, that the purest blood of the spermatic vessels is impelled hither, just as to the epididymides in men.* The spermatic vessels, together with the hypochondriacs,[1] pour their blood around this whole mass, and by their capillary terminations enter the corpora lutea; not to mention the nerves or fibres, which here form wonderful plexuses.

256. *And lastly, as regards the ovules themselves, these in women correspond to the testicles in men; for they take up that same essence within their membranes, or within the membrane, from the corpora lutea or epididymides. They are therefore the last receptacles, and are placed at one extreme, while the testicles occupy the other; which two mutually regard each other as ends; that is to say, they regard each other in the same way as do active forces and passive, efficients and recipients, or essence and form.* This follows from the connection of the parts, and is fully confirmed, nay, plainly shown, by frequent experience. For the ovules or corpora lutea have frequently been observed to swell up, to bė there swathed in their first coverings, and as it were to undergo incubation. The corpora lutea give the first nutriment, then the Fallopian tubes, and lastly the uterus. He who denies this, denies experience. *But the ovules are merely receptacles, and are scarcely anything more than a mere cicatricula such as is found in the ova or eggs of birds;*[2] *nor is more juice applied to them than suffices for the first moments. On this account, the ovum undergoes no increase in size until it is quite filled or impregnated with the new spirituous guest.* For it soon consumes these first fruits of humor, since it emulges its nutrition, not from its albumen or vitellus, but extrinsically from the corpora lutea, the Fallopian tubes, and the uterus, that is to say, from the parent herself.

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[1] *i. e.* the internal iliacs, see n. 277.

[2] By the cicatricula is meant the small spot or disk observable in the fecundated egg, and which contains the germ of the future chick.

257. *In this way also, we understand how not more than a single ovum is impregnated in the human species. For the vasa deferentia, all the way from their first juncture with the ligaments in the vicinity of the uterus, are filamentary, that is, are a mass of threads, and each thread is a determination to its own vesicle. That thread which is first opened, or which corresponds to the ripest ovum, must be opened of necessity; and then, by virtue of the swelling of this thread, the rest of the threads, not yet sufficiently open or gaping, are more tightly shut. Thus open way appears to be allowed to one ovum only. It would be otherwise if the seed approached the ovaries from without, and impregnated the ova before impregnating the underlying corpora lutea,—which, however, is contrary to experience.*

CHAPTER XIII

THE FALLOPIAN TUBES.

258. HEISTER. (*Compend. Anat.*) The Fallopian tubes[1] are two canals, almost conical, tortuous, and joined, one on each side, to the fundus of the uterus. They enjoy a close and continuous connection with the uterus, and a loose connection, by means of the alæ vespertilionum, with the ovaries. Their length is from six to seven finger breadths, and sometimes as much as eight or nine. Their calibre at the middle is almost equal to the thickness of the little finger. Their extremities are narrower, and the extremity by which the tube joins the uterus is quite narrow, opening into its cavity, and giving passage to air or to a fine stylet. The other extremity floats freely in the abdomen, is more ample, admits the passage of a moderate sized tube, and is furnished with a number of fimbriæ or fringes, as it were, of a muscular character, which, when need is, apply themselves to the ovary. In substance the Fallopian tubes are membranous and cavernous, consisting of two membranes, the outer of which seems to be continuous with the peritoneum, and the inner, with the inner membrane of the uterus. The latter is wrinkled, and is moistened with a lubricating humor; but it is not cellular, as in animals. Between these membranes there are vast numbers of vessels constituting a corpus cavernosum whereby the tubes are capable of being erected or made stiff when about to be applied to the ovary; and whereby they are moistened on their inner surface. In hens and other fowl, they are called oviducts. (n. 238.)

259. WINSLOW. (*Expos. Anat.*) The Fallopian tubes are two flaccid, conical, and vermiform canals, situated more or less transversely on each side of the uterus between the fundus and the lateral parts of the pelvis, and enclosed in a duplicature of the anterior leaves or alæ of the broad ligaments.

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[1] See Plate VI, fig. 2, Plate VII, fig. 1

Each of them is fixed by its narrow extremity to the corner of the fundus into which it opens,—but by so narrow a duct as hardly to admit a middling sized silk thread. From this place the diameter of the tube gradually increases all the way to the other extremity, where it measures about the third of an inch. The tube runs a somewhat winding course, and its large extremity is curved back towards the ovary. These large extremities are irregularly rounded, and terminate by a narrow and slightly plaited orifice which faces towards the ovary, where it presently expands in the form of a membranous fringe called the fimbria of the tube. The fimbria is not of equal breadth throughout; its circumference being in a manner oval. The longest of the fringes reaches out towards the ovaries, where it is attached. The folds are on the concave side of the fimbria, disposed like laminæ. The tubes are composed of fleshy fibres, some of which are longitudinal, and some obliquely circular, but all interlaced with another very fine substance. The anterior ala of the broad ligament[1] serves as a means of attachment, and as a common or external coat to both tubes, in the same manner as the mesentery does in relation to the intestines. This renders the tubes, and especially their fimbriæ, more or less floating, and as a result most figures dilineate their direction as being very indeterminate. Their cavity is lined by a soft, and as it were glandular membrane, which is plaited longitudinally, almost like the inner surface of the trachea. These folds are more prominent, stronger, and broader in the ample extremities, than anywhere else. They are a kind of spongy substance, and the interstices between them are more or less moistened by a lymph which is continually oozing forth. (*Tr. du Bas Vent.*, n. 607–613.)

260. BOERHAAVE. (*Instit. Med.*) The Fallopian tubes are flexed into cellular semicircles; the fimbriæ girding their wide extremities are fleshy. They consist of an inner glandular membrane with strong fleshy bands. In nearly all kinds of animals, during the venereal orgasm these tubes swell, stiffen, and blossom with carunculæ. In the bodies of women submitted to dissection the tube has often been seen embracing the ovary in its fringes. Moreover, in its cellular recesses fetuses have been found in various situations, in various stages of development according to the time from conception, and of various sizes. (n. 668.) [Describing the progress of the ovum, Boerhaave says that the tube with its stiffened fimbriæ embraces and presses the ovary, and in the embrace expands its opening, and gradually urges the ripe ovum into the cavity.] False conception, abortions, the presence of fetuses in the cavity of the abdomen, etc., all prove this to be the case. (n. 671, 672.)

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[1] That is, the anterior of the two membranes of which the broad ligament is composed; see Plate VII, fig. 1.

261. MORGAGNI. (*Advers. Anat.*) On a first examination and inspection, I have often thought that the tubes were closed in some part, and particularly at the uterus; whereas the fact is, that on careful search and dissection I have hardly ever found them closed. After the tubes have mounted the dorsum of the testes, they frequently pass down behind the latter, and hang forward below them, with their orifices looking sometimes downward, sometimes upward (I, § 30). [On careful inquiry instituted upon the bodies of twenty women, young and old, virgins, wives, and mothers,] in thirteen cases, the tubes (often those on both sides) were found to be curved in such a manner that, after mounting the testicles and then descending at their hinder parts, the orifices of both of them were for the most part turned downwards; sometimes, however, the orifice of one of the tubes, and occasionally of both, was turned upwards (IV, § xli, p. 74). In a dog and a hedgehog the terminal membranous expansion of the tube was found to be fashioned into a sacculus or little bag, garnished on the inside, if my memory serves me, with fatty stripes, and closely embracing the ovary. Wharton, as De Graaf relates, found the tubes of a pregnant mare provided with a number of valves throughout their whole extent; but in the tubes of a mare not in foal Morgagni was unable to find a single valve (IV, § 30).

262. SCHURIG. (*Muliebria.*) The old writers called the tubes broad ligaments, antenæ, spiramenta or breathing holes of the uterus, oviducts, cornua, and also vasa deferentia. (III, iii, § 1.) They are attached to the testes only by a most delicate membranous connection; De Graaf (§ 5). Cases of tubular conception sometimes occur. Ruysch found the tubes or oviducts sometimes distended and deep red on account of conception.—De Graaf mentions that in abnormal cases the tubes have been found closed. Ruysch reckons the closure of the tubes as one of the causes of barrenness; and if they are closed at their extremities, he has generally found them firmly adherent to the ovaries.—Caspar Bartholin says that in the rabbit they are closed by valves, and that the passage cannot be forced by air blown in with ever so much force, nor by water injected by a syringe from the side of the uterus [but injected in the opposite direction, that is, towards the uterus, it went through without difficulty].—Ruysch thinks it very probable, that in abnormal cases the menses and other heterogeneous humors escape by the tubes into the cavity of the abdomen; Schurig quotes Ruysch's observation of the fact. Blood likewise he considers may pass by this direction. (III, iv, § 8–10, 12.)

INDUCTION.

263. *That the Fallopian tubes receive the ova from the testes a few days after coition, and convey them along their canal towards the uterus, is a conclusion that anatomical experience alone both confirms and demonstrates. For anatomists have seen the tumified ova; they have seen also the ruptured external tunic, and the resulting cicatricula; and finally, they have seen the fimbriæ or fringes with their little mouths erected towards the ovary, and the ova themselves at various distances from the uterus. They have also seen fetuses in the tubes, and others which had escaped into the abdominal cavity, besides many other phenomena; from all which it follows, that nothing is lacking, except indeed actual sight, to bring us the conviction that observers have seen the passage into the tubes, the transmission through them, and the passage into the uterus.* In view of all these convincing facts brought together and confirmed by so many trustworthy authorities, there is no longer room for doubting that the Fallopian tubes are oviducts; though with respect to the passage through them of the material seed, or even of its spirituous part, doubts may justly be entertained. *It is also an admitted fact that, at the time of the separation of the ovum from the ovary, these tubes apply themselves and their fimbriæ to the ovary, and embrace it so closely that the ovum can do no other than roll down into that orifice.* The erection of the tubes is a fact that has been actually seen and noted by many anatomists, and, indeed, in by far the most cases, on about the third day after impregnation. Moreover, it has been seen and noted, that a similar application occurs in cases of inflammation of the tubes. We are therefore justified in concluding that at the time of the separation of the ovum the union between the tube and the ovary is a very close one, and is, in fact, of such a nature, that by means of these finger-like determinations of the fimbriæ, the ovum is bound to run into the orifice. But in this connection many questions arise: Why are the tubes distant from the ovary? Why, in their flaccid condition, do they look downwards rather than upwards? For what reason are they unattached rather than attached? And by what cause are they erected and suitably adapted? What are the causes that provide against the ova frequently falling into the abdominal cavity? Not one of these phenomena is without its cause; for nature, especially in the animal kingdom, never constructs the least hair's breadth excepting for a cause and for an end. Thus there is no least capillary thread, nor any direction of a fibre, that does not exist for the sake of a cause, or for the use of the parts that follow.

264. *As soon as the spirituous part of the sperm has arrived at its genital bed, that is, at the corpora lutea, and thereafter at the little doors of its ovum, it straightway girds itself for the work of taking up and forming the thread of its new life and new body. For the purpose of this work, it brings into partnership, by means of the threads of the vas deferens, every part that is genuinely spermatic, and thus commences the web. For it is the inherent nature of this essence, that wherever left to itself, it inmostly yearns and strives after the formation of this web; since it regards that which is yet to be formed, as already formed; and in first and middle ends, it regards ultimate ends; and in its progress from firsts or principles to extremes and effects, there is nothing that does not minister to it. When therefore it has gained this first position, it straightway enters upon the work; and thus proceeds in the same way as though it were proceeding in a body already formed; for in it lies the most perfect representation of such body.* But on these subjects see above [n. 40, 170–171 and particularly n. 175]; see also Trans. I [n. 261–262, 263–265]; and still further in our psychological transactions, and in the Transaction on the Soul.[1]

265. *And as it resides with such a nature in its center or principle, it looks around upon all things, near and far, in the maternal body, as though they were its own property on which it may draw for everything that shall conduce to the formation of a new little*

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[1] That is, Trans. V and VI, see n. 10, note. With regard to the references in the text, see FIBRE, n. 274–279, 280–281; and the little work on the Origin and Propagation of the Soul (in Post. Tracts).

body. First, therefore, it demands of the fibres the most chastened spirit, and of the vessels the purest blood; for of these elements it weaves its primitive form. For whatever the extreme demands, all things in the whole of that microcosm must supply; thus whatsoever [the spirituous part of the sperm] demands of the fibres, and whatsoever it demands of the vessels, the thing demanded, wheresoever in the nervous and sanguineous system it be, is bound at the call, to contribute its share. First then, it summons from the spermatic vessels the purest essence of the blood; and from the fibres of the sacral nerves, par vagum, and intercostal nerves, in a word, from the brain, it summons spirit and whatever this spirit brings with it; and this, that it may make choice, and may appropriate to itself whatever is suitable. This is the reason why one or two days after impregnation, the whole of the system, sanguineous, nervous and membranous, undergoes a remarkable change. One might think, that a portion of blood and spirit so tiny as that which impregnates the ovum or its corpus luteum during the first days could not induce so great a change. But since only its most spirituous and purest part or the inmost extract of the blood, that is to say, its quintessence and thus its supreme quality, though not quantity, is required, it must certainly follow that the supplying of this demands the assembling, as it were, of the whole mass of the blood; for from a great volume, only a little of the most subtle essence can be extracted. On the first days of all, nothing but the purest element is demanded. This must be supplied by the entire mass of the blood, and particularly by the spermatic vessels, which now first begin to open their purest passages, and to proceed to the work. This is the reason why the blood of the whole body communicates with the blood of the uterus, Fallopian tubes, and ovaries; and why the spermatic vessels have direct communication with these organs. For the blood of the spermatic vessels comes not only from the mid-aorta, but also from the iliacs, that is, from the external hemorrhoidals as well as from the hypochondriacs,[1] thus from the whole mass of the blood. In like manner [the supply of spirit] comes from the several fibres that are proper to the cerebellum, as from the par vagum, the great intercostal, and the sacral nerves.

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[1] *i. e.* the hypogastrics, or internal iliacs, see n. 277.

Therefore, the place where the ovum resides, and, in this place, the, as it were, new beginning, must now be considered as a kind of center, and whatever lies in the maternal body as the peripheries whence the center draws its legitimate and purest essences. This is the reason why the whole sanguineous mass of the bloodvessels, and the whole spirituous mass of the fibres, is now at the height of work, and, as it were, boiling hot. Add to this, that the soul itself, which regards effects simultaneously with ends, and views them simultaneously as present in one series, and is distinctly conscious of this mutation, now bestows all its labor to the end that in this center it may pour in a new life as it were; for it there regards itself as a transcribed and new soul,—a soul in which it may hand down its life to posterity. At this time, therefore, it represents to itself in the body already formed, that is to say in the maternal body, an instrumental cause as it were, which exists for the sake of this new progeny. Thus it bends its whole endeavor to the propagation of this offspring. Here again we find a correspondence with a similar affection in men; for in the venereal heat men are in the endeavor to pour out all their spirits or life into the new offspring that is to be propagated, and thus to found as it were a colony in another being, a likeness of themselves [n. 46, 145]. The same is the case here. And already the soul is in the effort to project all its life into this new life. And therefore the soul is now at the utmost height of work,—a fact, however, which does not come to the consciousness of our mind except by means of the ultimate effects, which are conspicuous enough; for the whole work of generation is carried on within nature and outside the consciousness of our rational mind. Thus from the cause, conclusion can be drawn, not anatomically, but only psychologically.

266. *Since, therefore, when the state is thus changed the spirit and blood are in a kind of inmost fervor; and since a minute quantity of the finest quality is to be drawn out from the universal mass of the blood,—the soul with all its forces, exerting itself to this end,—therefore, it is needful that an abundance of blood should stream thither from all directions, and thus inundate, as it were, not only the ovaries, but also the Fallopian tubes, and the uterus as well; and this, in the ratio of the quality and quantity required.*

Hence it comes to pass, that the several parts are brought into a harder and more swollen state,—those that were previously flaccid becoming now erected. In this way the Fallopian tubes, which otherwise float freely in the abdomen and face downward, are now contracted; and each tube, acting in the direction of its fibres, including the motor fibres, nicely applies itself by its extremity to some place on the ovary of the same side, and presents itself as an instrument for the reception of the ovule that sails into it. These positions are confirmed by the effect; namely, by the fact that the Fallopian tubes perceptibly erect themselves to embrace the ovary, as has been observed by many anatomists; and this, not at once, but by degrees, as the ovule is filled out and thus prepared for its first birth or delivery; that is to say, as it is supplied, first by the purer blood, and then by the grosser. The position is also confirmed by cases of inflammation of the ovaries, when, according to Ruysch's observation, the tubes are completely erected, and apply themselves to the ovaries.[1] The alæ vespertilionum also contribute powerfully to this result by colligating the curvatures of the tube and binding it to the front part of the ovary. The tubes are first disposed to this mutation by the purest nervous fibres,—which are inserted in great quantities,—and by the membranes, especially the inmost membrane; then by grosser fibres and vessels; and lastly by the muscular fibres, of which also the tube is said to consist. Furthermore, when the blood fills up the cavernous substances or the septa between them, as in the case of the penis, of which above [n. 151–153], erection of the whole tube follows, including also the fleshy appendages or fimbriæ. For they are so twisted and as it were convoluted around the entire extent of the ovary, sometimes like the spirals of a screw, that when contracted they cannot at once completely apply themselves to the ovary on account of the convolutions. Thus assuredly all things are disposed in every respect according to the end foreordained by nature.

267. *These tubes must needs have a double motion, namely, a pulsatile motion according with the movements of the heart, and*

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[1] We are unable to find this observation in Ruysch's works. But he mentions several cases of disease where the tube was found closely applied to the ovary; see *Obs. Anat.* *83, seq.*

an expansive and constrictive motion according with the movements of the abdomen and peritoneum, that is, of the respiration of the lungs. For an abundant supply of blood creeps through them and is everywhere pushed on, in order that the blood in circulation may be always fresh; for it is driven out in large quantities into the veins, which are therefore very numerous and swollen. That there is also an expansive and constrictive motion, is proved by the connection of the tube with the peritoneum by means of the common tunic and the alæ vespertilionum; for these alæ lie between the curves of the tube like networks, and join them together, just as the mesentery does in relation to the intestines. That the peritoneum is expanded and constricted by means of the muscles of the abdomen, and this during the times of respiration, is evident; and hence the same is also true of all those appendages to which this general tunic of the abdomen is continued.

268. *Thus, since the tube is alternately expanded and constricted, and this by means of its tunics, namely, the internal or nervous, and the external, it follows, that the cavity which it encloses is also alternately extended and contracted; and, since it consists of folds, is alternately unfolded and folded. This is the cause of the forward movement of the ovum from place to place and finally towards the orifice into the uterus. In order that the ovum may be pushed forward from a larger cavity into a lesser, this movement must be effected by some active force ,that is to say, by some motion,—as is the wont everywhere in the vessels and tubes of the body; for instance, in the arterial vessel, the trachea, the bronchial tubes, the œsophagus, and many others.* For there are foldings and rugæ, which, by some, are also called valves, whereby the cavity is discriminated; and these cannot fail to implicate the ovum, to adapt it to themselves, to everywhere offer it some new bed, and at the same time to hinder it from slipping back again. For of itself, the little ovum is most highly active [and would at once slip back to the larger cavity] unless it were everywhere involved in a network of this kind, and at the same time in the humor peculiar to the tube and which comes from its glands, or rather, from its cavernous substance. In itself, moreover, the ovum is of the highest levity, and in its state of activity is almost devoid of weight and downward effort; then too, the outmost orifice does not now look downwards. Thus of necessity the ovum is pushed forward to the narrower parts of the tube, both by its own proper force and effort, and also by an external force. Moreover, whilst the ovum is in this state, that is to say, whilst it is most highly vital and is nothing else than the spirituous essence of the sperm now coalescing into a carina and most distinctly mobile in its least parts, it seems also to enjoy an elastic force; that is to say, to be capable of adapting itself to every dimension; as is the case with the softer blood, or the primitive or white globules of the blood; see Trans. I. [n. 148, 149, 158 *seq.*, 199 vii.]

269. *Commencing from its first stem, the embryo seems to have three different births or deliveries. The first birth is when it is excluded from the ovary and passes into the Fallopian tube; for it then puts off its finest secundines,*[1] *namely, the corpora lutea, which like intestines have embraced its middle portion. It is again born when, having passed through the cavity of the tube, it is expelled into the uterus. And it is born for a third time when it is at last excluded from the uterus and the infant is brought forth. The divers changes that it undergoes in its first epochs and diminutive ages, are hidden from our ken; for we have no apprehension of this period from anything of visual experience. But certainly there seem to be in the embryo three natural instincts, namely:* [1] *Of detaching and loosening itself from the ovary and its bonds, and of striving towards the applied tube.* [2] *Of desiring to be expelled from this tube as from a vas deferens into the uterus.* [3] *Of desiring to be expelled from the uterus into the light of day,—with respect to which last birth we have from observation some little knowledge as to the instincts and accessory causes by which it is effected.* These final efforts for expulsion from the womb will be treated of elsewhere. As regards the first birth or that from the ovary, almost a similar one occurs in all the plants, flowers, and blossoms of the vegetable kingdom. For there is a kind of farina like a seminal aura, which, excluded in its ovaries, seems to be conveyed by the adaptation of the leaves, as of the fimbriæ of the tubes, into the theca where the little seeds are finally stored up. This was proved to me by many observations, and clearly demonstrated by my recently deceased friend Petrus Aroselius,[1] a man of the most distinguished learning in the science of botany. We may conclude, therefore, that animal nature in these respects conspires entirely with the nature of the vegetable kingdom; showing that there is a kind of most common law of nature, welling out from the inmost sanctuaries of her science.

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[1] The secundines are all that remains in the uterus after the birth of the child,—namely, the placenta, a portion of the umbilical cord, and the membranes. The term is used here by analogy, as applied to the ovum.

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[1] From the "Matricula" of the Westmanland-Dala "Nation" of the University of Upsala, we learn of a Peter (Pehr) Aroselius, who was born in 1700. In 1708 he was entered as a student of Upsala University, where he was enrolled as a member of the Westmanland-Dala Nation, of which Swedenborg, who entered the university in 1699, at the age of eleven years, was also a member. It was in this year, 1708, that the Nation elected Swedenborg a senior of the university, and he remained there until 1709 when he completed his university studies (*New Church Life*, 1903, p. 528, 532). Respecting Aroselius, we learn further from the Matricula that he became a minister in Mora in 1723, and died in 1742. According to the VÄSTERÅS STIFTS HERDAMINNE (Biography of the clergy of the diocese of Västerås), he took holy orders in 1723, when he was appointed to the parish of Rättvik;—both Mora and Rättvik were prominent parishes of Dalecarlia situated not far from Swedenborg's ancestral home. Whether this Aroselius is the one referred to in the text, is not known with certainty: but that it may be assumed as highly probable is indicated by the reference to the latter as being "recently deceased" (*jam defunctus*),—which can apply only to one who had died either in 1742, the time when GENERATION was written (see Preface), or shortly before. The identification is further strengthened by the investigations kindly instituted by Dr. Aksel Andersson, the learned librarian of Upsala University, to whom we are indebted for the above particulars respecting Petrus Aroselius. The only other persons of this name of whom Dr. Andersson could find any mention are, an officer of the College of Mines, who died in 1789; and the father of the same (1679–1736), who was a civil officer under the Crown. The latter however was enobled Adlerheim in 1719, and he would hardy be referred to in 1742 as Aroselius. The clergyman Aroselius and the civil officer Adlerheim were both related to Swedenborg, their common grandmother, Catharine Behm, being a sister of Swedenborg's mother. Beyond the reference in the text, and a possible association in the University during the years 1708–1709, nothing is known of Swedenborg's relations to Aroselius. The latter's knowledge of botany, however extensive it may have been, would seem to have been acquired as the result of amateur study; for the name Aroselius is unknown to the botanical literature of the times.

270. *There appear to be most pregnant reasons why the fimbriæ of the tubes are not constantly applied to the ovaries but float freely in the abdomen; why the orifice itself faces downwards; and why, as soon as the time of the first birth is at hand, the fimbriæ at once erect themselves in suitable manner. Many reasons indeed occur to us, but they are conjectural and hypothetical. One of such reasons is, lest by the more rigid and continued contact and rubbing, the ovaries, and consequently the ova themselves which lie under them, should be irritated; for the least friction insinuates a kind of vibratory motion, which would be at the expense of the first formation. When therefore the fimbriæ finally approach the ovary and come in contact therewith, at first gently and afterwards a little more roughly, then by the continuance of the pulsatile motion, the ovum seems to be excited to such force, that, with the aid of administering means, it finally bursts the outmost tunic.* It appears necessary that the ovaries should be free from contact, and as it were left to nature which acts from inmosts,—and this, lest any change happen to them from external forces, and disturb the natural series. Wherefore I know not whether there be anything in the whole body that is so free by one of its extremities, as the ovary. Thus there seems to be here an ending or a kind of last station, beyond which there must be no further communication with the body; for beyond, something new is to be propagated that shall enjoy a body of its own, and shall not be connected with the parent body. Therefore, when the ovum bursts out from this last station with the first animal form, it bursts out into a kind of different body, and one not common to its parent. This station, moreover, is the last thing that corresponds to the organs of the man; for the tube and uterus are members proper to the woman and do not have any such correspondence but belong rather to the future offspring; that is to say, they exist in order that they may be the beds of its formation. But these conjectures are only plausible and perhaps probable.

271. *From the connection of the parts, however, it may be deduced, that active forces and reactive follow each other and pro-*

gress in the same order as conception itself. For the first active force begins in coition itself, in the cervix of the uterus where the forces at the time are at once concentrated. Afterwards it exists in the vas deferens; then, in the very place and cushion of the ovum, which during the first days is the beginning of all the action that goes on in the blood and fibres, that is, in the circumferences. It next exists in every point of the ovum's progress in its downward course through the Fallopian tube; and finally in the uterus itself, at the place where the ovum attaches the placenta. Then, to this spot as to a kind of active beginning, all the determinations of the spirits and of the blood that are suitable for this work, flow in in confluent streams. It is the ovum itself, and the appetency and suction of the enclosed embryo, that induces these changes; for whatever quantity and quality, whether of blood or of spirits, is anywhere expended, this the whole mass of the blood must supply. Thus wherever the ovum penetrates, there it forms a kind of center, and as it were a living fountain to which the rest stand related as streams. This seems to be the reason why the fimbriated extremity of the Fallopian tube is not attached to the ovary; for were it so attached, this center of activity would be unable to perform this course and circle, since these activities might possibly proceed in inverse order; that is to say, the blood of the tubes might either be drawn back towards the ovaries, or from the uterus itself into the tubes; when yet the progression must take place in such an order that the activities follow each other from the ovaries into the tubes, and so onwards into the uterus. But these statements are perhaps somewhat obscure. The meaning is, that during the first days, the blood and the spirit of the fibres must be derived from the whole mass to the ovum and its corpus luteum or calyx, yet in such a way that the Fallopian tube also shall enjoy an abundant supply of blood. This would not be the case were the tube attached by these extremities to the ovary; for then the blood and spirit of the tube would also run into the ovary, which would result in the tube not being properly erected. Afterwards, however, when the ovum has got into the tubes, it is no longer the ovary that requires this supply of the purer blood or spirits, but the tube itself, which draws juice also from the ovary through the alæ vespertilionum. Consequently, when the passage or transmission through the tube has been accomplished, then follows an afflux of blood to the uterus, and, in fact, to the placenta; but this order of procession would be impossible were there an immediate communication between the tube and the ovary. I am not indeed unaware that one of the most experienced observers (Winslow) affirms [n. 259] that the longest fringe of the tube is attached to the ovary,[1] but since, with this exception, it is the general consensus of opinion among skilled anatomists, that this fimbriated or fringed extremity of the tube floats freely in the cavity of the abdomen, I can do no other than found my reasonings on their experimental testimony. But possibly these reasonings may appear to be imaginative,—a matter which may be left to the judgment of others. This, however, is a constant truth, namely, that the universal mass of the blood regards the ovule in which the living embryo is enclosed, as the center of its activity, wheresoever that ovule be attached; and that the ovule sucks out something from the blood; so that it is this suction that is the cause of the mutations in the body of the parent,—as will be seen more plainly in the uterus, where all the arteries and veins not only swell up, but also completely adapt themselves in such a manner that they strive to meet in confluent streams about this new center of life. The natural equation also requires that the peripheries shall supply whatever the extremes consume; and the ovum, be it tarrying where it will, is still in the very extreme.

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[1] According to Piersol's ANATOMY this is often, but by no means always, the case; for the longest of the fringes, while invariably extended towards the ovaries, is frequently unattached thereto.

CHAPTER XIV

The Uterus.[1]

272. *Following the successive order of operations, the uterus comes last; for it takes up the ovum, attaches it to its walls, cherishes the enclosed embryo nourishing it from its own life and blood, and accommodates itself to the several offices required for the formation of the new mannikin before he begins to live from his own proper life.* This is clearly evident from the fabric of the uterus and from its mode of effecting the work of formation.

273. *As soon as the ovum glides into the uterus, it at once attaches itself to the neighboring part and there fixes its abode, applying to the wall of the uterus that same part which it had previously applied to the tortuous corpus luteum. Relatively to the determination of the fibres of its tunic, and hence relatively to the determination of its motion, the ovum when naturally left to itself must be conceived of as being furnished with a pole or center of rest. This center is represented in all those points where it had been primitively attached by its radicle to the corpus luteum in the ovary. This its radicle, after passing into the uterus, must needs be attached to some particular plane of the nervous, smooth, lubricous, and inmost tunic, and must completely accommodate itself thereto; and consequently, must there interpose a kind of placenta, and by this again, draw out a great peduncle or footstalk, that is to say, the umbilical cord.* It cannot be a matter of doubt to any one, that in the ovule, which is otherwise round, there is a certain part which, in the ovary, had been attached to the corpus luteum as to a primitive uterus, and through which the seed, together with foreign spirits, has insinuated itself; for the peduncle itself is a matter of observation. This part must by all means be the most quiet in the sphere of the ovum,—according to the rules constantly dwelt upon above.[1] The very direction of the fibres, and, following this direction, the nisus of circumvolution, must stand related to this place as to a pole or focus; consequently, when this ovum has been torn away from its first womb, there must necessarily be a little scar or cicatricula left at the spot, and some thickened part formed by the retracted extremity of the primitive peduncle. Thus when the ovum rolls round and round, whether in the Fallopian tube or in the uterus, it can naturally present to the inmost membrane of the tube and uterus, no other part than this; for through this part alone is there offered a natural way into its interiors. In this same part likewise is the center of rest, and consequently the center for the inflow of new aliment. *To this part exactly corresponds the inmost tunic of the uterus, which is smooth and consists of nervous fibrils, and which applies itself homogeneously to the tunic of the ovum which consists of similar fibrils. The ovum therefore cannot be applied to this tunic until the former has attained such size that the instrumental causes, which are the fibres and vessels of the uterus, shall correspond to it as the principal cause. This is the reason why it was necessary that it first make something of a delay and journey in the Fallopian tubes, and why, on the way, it here and there struck its root; for, thus inaugurated by continual usage in the tubes, it preserves entire the faculty of striking root, all the way to the uterus.* Hence everyone can see and conclude as to why the ovule passes through the Fallopian tube,—namely, in order that at the several points of its passage, it may become slightly adherent to the walls and folds; and as to why these tubes and the uterus are furnished with a subtle nervous coat.

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[1] The anatomical experience on which the inductions of this chapter are based are included in the quotations that precede chapter XI, On the Vagina and Cervix (n. 215 *seq.*).

274. *This ovum, fecundated with the rudiments of the new embryo, then establishes a kind of center of bloodvessels and fibres in the place where it has struck its little root and fixed its abode. For whatever the uterus possesses in all its border or circumference it now brings to this spot; and the several streams dispose themselves like circumferences to the center of their activity. And therefore, with one common eye, now look hither all the parts whatsoever that have their seat in the dense tunic of the uterus, and like-*

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[1] See n. 14, note, and 1 A. K., n. 104, 304; 2 A. K. n. 450, 538.

wise those that have their seat in the substance of the Fallopian tubes as well as of the ovaries. If then all these several parts aim hither, it is necessary that new ways as it were,—ways that before had been blind ways,—should now be opened in the direction hither; and that all the ducts, as paths of determinations, should be here brought together, and thereby all the contents of the vascular substance and all the contents of the common tunic continued from the peritoneum and all the contents of the inmost or nervous tunic. The latter, which plays the first part and contributes the purest juice or spirit, seems with all its fibres to be bestowed hither and to converge into the placenta, in order that the fibres of which it is woven may be continued even into the new little body; and, following the umbilical cord, that is to say, in the body itself, may combine with the fibres proper to the embryo and make a complete one with them; and this even until the embryo's own fibre, hatched from its veriest brains, can play its own part without any assistance from the fibre of the mother. Thus the whole of the little embryonic body may be considered as being at this time like an appendage to the maternal body, and this, until the connection, thread, or umbilical cord is broken; that is to say, until the embryo's two brains have advanced to such an age, that it can provide itself both with fibre and with juice and blood. That the inmost membrane of the uterus is contracted, and as it were derived to this center, is evident from the loss of this membrane in pregnant women.[1]

275. *From this concentration it undoubtedly follows that in the place where the placenta is fixed, a peculiar corrugation is found; and since there is no lack of bloodvessels of both kinds, nor of nervous fibres, therefore, by reason of the activity, there is there formed, according to the common custom everywhere observed by animal nature, a species of muscle, whose fibres adapt themselves completely to the ratio of both the motions.* Ruysch makes mention of an orbicular muscle as existing at the part where the placenta is attached; many keen sighted anatomists have also sought for this muscle, though in vain,—finding only fibres emulous of motive fibres and determined in all directions [n. 216]. But nothing is more usual in the animal kingdom, than the formation of muscular fibre wherever there is any motion or reciprocal action; nor is anything more easy, since an abundant supply of vessels and fibres is at hand; and it is of these that muscular fibre is made up. This operation comes into play in all preternatural growths; how much more so in this growth, which is highly natural. The same conclusion is also confirmed by the motion of the uterus after delivery,—a motion which, as noted by Ruysch [n. 231], is sometimes violent,—when the now ruptured fibre contracts in various modes, and still, as though it would continue its activity, retains for some time its pristine motions and endeavors to act in like manner as before. Moreover all the fibres and vessels concentrated to this point must undoubtedly enact a certain common cause.

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[1] *Cf.* n. 216 and note.

276. *The second office of the uterus is to blandly foster the enclosed embryo, and, as its months roll on, to feed it with the mother's life and blood. That it may perform this office aright, the uterus so disposes itself that it may, so to speak, convey hither not only all that itself carries in the bosom of its tunics but also all that is carried in the vessels and fibres of the whole maternal body. For the new infant or embryo now naturally considers the whole surrounding body of the mother as a microcosm devoted to itself; and all that this microcosm carries, in whatsoever part it be, it reputes as its own. Thus at this time the mother seems to live for the new infant, but not the infant for the mother.* A similar relationship is evident after birth; for maternal love is a union of such a nature that the mother seems to live for her offspring and not for herself. The soul of the mother seems to wish to transfer itself as it were into the new soul of the offspring. This is the real cause of maternal storge and the cause also of its effects, which are, that mothers will face death for the sake of their infants. The like also obtains in brutes; at such times the most timid beasts, laying aside all fear, advance against an enemy and fight with him, and thus face death for the sake of their offspring. The like therefore occurs in the uterus; but it does not come so distinctly to the consciousness of our mind, since it lies in the occult sphere. Nor is it excited by any external sense such as sight or touch, as is requisite in the case of animal life, where the external senses must also be present in order that the whole series may be completed. So long as an effort lies in the soul alone, it lurks under the appearance of instinct, nor is it taken cognizance of by our rational mind until similar causes in its posterior and sensible world conspire with it.

277. *In order then that the enclosed fetus may draw from the maternal body as from the sphere of its own microcosm, all that the plan of formation requires from the very beginning to the ultimate end, it is necessary that there be a constant intercommunication between the bloodvessels,—not only between those of the uterus, Fallopian tubes, and ovaries, but also between these and all the bloodvessels throughout the whole body; thus that there be no freightage carried by the least arteriole, wheresoever situated, that is not common to the vessels of the placenta and consequently to the body of the embryo.* This is the reason why there is so constant an intercommunication between all the vessels of the uterus; that is to say, between the branches that come from the hypochondriacs, those that come from the hemorrhoidals, and those that come from the spermatics. For when any single artery is inflated all are inflated. This is also the reason for the extreme frequency of the anastomoses, and for the several modes of contortion found in the vessels; to the end, namely, that all may be able to apply themselves to the center of activity and to be confluent thither. These hypochondriac vessels, that is, the internal iliacs, spring from the first bifurcation of the aorta, while the spermatic vessels spring from the aorta itself just under the emulgents. The fact of these two origins enables us to conclude that there is not a single drop of blood passing through the heart and propelled into the aorta that is not common to the uterus, that is to say, to the enclosed infant.

278. *Yea, whatever is carried by the fibre, which belongs to the body and springs from the cerebellum, is also common to the embryo. The latter therefore can extract from the very fountain, that is, from the cerebellum, just as large a quantity of spirit as it requires.* This is clearly shown by the determination of the fibres. For all the fibre that finally issues from the spinal sheath into the sacrum is fibre of the cerebellum that remains after the passage through the spinal axis. Moreover, all the fibre that constitutes the mesenteric plexuses is fibre of the cerebellum; for these plexuses are formed from the intercostal nerve, and the eighth pair of the head.[1] That these nerves are proper to the cerebellum, see Trans. I [n. 478–479, 485 *seq.*; see also n. 44 above]. I find also that this fact was known to Hippocrates. This fibre is now at the height of its expansion and prodigality, for it opens itself right out to supply the formative substance; see above [n. 45–46, 145, 265]. And since in the body, fibre does not communicate with fibre in the same manner as vessel communicates with vessel (for from their beginnings to their ends in the muscle, fibres run as single canals), therefore this effect is referable to the fountain head, that is, to the cerebellum where communication does exist; and that fibre which at its extremity makes a larger demand gives also a greater supply. Hence upon the fount itself, that is, upon the cerebellum, depends the circumstance that the whole wealth of the spirits makes common effort hither and leaves to the rest of the fibres no more than what is superabundant and not requisite and necessary for the infant. These phenomena are the causes of many changes and symptoms that occur in gravid women; concerning which matter more will be said below.

279. *Besides the vessels and fibres, the whole interior surface also, or the inner tunic of the mother, namely the peritoneum and in part also the pleura, pours on all that it carries in its fibre and in its cellular tissue, according to every necessity of the growing infant. Thus nothing whatever is wanting for the infant's nutrition and increase, so long as anything remains in the mother's body from which it can draw forth the essences that it requires.* The peritoneal tunic with its cellular tissue continued all the way from the bladder to the rectum is folded over upon the entire uterus; nay it is continued, not by a simple course from the bladder around the uterus to the rectum, but it also passes by the several ligaments of the uterus,—the broad and round,—and around the Fallopian tubes, the ovaries, and the fascicles of vessels and nerves, that is, the spermatic cord; nay, further, by the alæ vespertilionum, it passes between the flexures of the Fallopian tubes, and between the latter and the ovaries. Thus there is a universal communication, importation, and exportation; for this process of the peritoneum is finally terminated in the pubic bones, and a part of it also in the adipose tissue where it is obliterated. If there be a complete communication with the peritoneum, there must also be some communication with the pleura, since these two membranes communicate with each other by means of the diaphragm. That this cellular tissue constantly transmits a species of fluid; and furthermore, that it does this in the parts where it is infarcted with fat, and particularly about the bladder, may be seen above.[1] Thus there is no lack of blood for the spirits, nor of spirit, nor of aqueous and oleaginous liquid of every degree and species. The vessels carry the blood, the fibre the spirit, and the peritoneum the suitable serosity. Thus there can be no lack, so long as anything is left in the maternal microcosm.

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[1] The par vagum.

280. *Not only the due quantity of nutritious juice is conveyed from the maternal body and uterus to the infant, but also the due quality; and indeed a different quality every instant, from the first moments of conception to the last when the embryo at last emerges from its prison-house.* For at the earliest period it requires nothing but the purest essence and the very spirit; afterwards successively it requires a grosser essence also, and at last pure blood and pure lymph; for the purest and first organs demand only a substance similar to their own nature; and so on successively down to the last moments. In the meantime the embryonic brain begins to furnish its own supplies. For the organs of the brain conceive from themselves, and as proper to themselves, a pure essence which they exclude into the fibres; and likewise the infant feeds on the liquor of its own amnion. Thus at the last period of fetal life there is not so great a quantity required from the maternal store. This is the cause of many changes that exist in the maternal body,—changes of the animus and body, of the appetites, of hunger and thirst, etc., all of which are observed in gravid women.[2] For when the purest essence is drawn off, then the mother's inner faculty is affected and suffers; a kind of lassitude occupies the joints, and she feels a certain deep seated disturbance of which she knows not the cause. Afterwards the middle or next lower essence, namely the animal spirit, is drawn off, whereupon the viscera are in part bereaved, and nausea, vomiting, and other phenomena, are the result. Then, when the nutritious juice and blood are drawn off, comes irrepressible and unusual appetite, and finally the outward features become drawn. These various drainings therefore induce on the mother various changes which follow each other in successive order.

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[1] *Cf.* n. 14, note, and see 1 A. K., n. 325; see also n. 86, above.

[2] See App. n. 7, 8.

281. *During the first period, therefore, chief in the work are the spermatic vessels which supply the purest blood and which constantly communicate with the hypogastric vessels of the uterus; afterwards, the spermatics holding back, come the hypogastric or iliac vessels; and lastly the hemorrhoidals. According to the quantity and quality that is required, so the vessels dispose themselves and engender new anastomoses; nay, their pores and extremities suitably adapt themselves and open up.* That the arterial pores and extremities open out into the uterus is clear from the fact of the menses, and from the very fabric of the uterus; and that the ducts and the continuations from the arteries, which were previously in a manner closed and colorless, are now opened and carry red blood, is also beyond doubt; as likewise is the fact that vessels which were previously of small calibre are now much swollen. *The like is the case also with the venous vessels which form as it were entire sinuses and are asylums and receivers for the blood and consequently dispensers thereof; to the end that the due quantity and quality of blood and serum may be dispensed according to every necessity. This also is the reason why the thickness of the uterine substance is permanently the same throughout the growth of the embryonic body.* This is abundantly evident from the observations of the learned. When the arterial and venous threads previously almost closed are again opened and the larger vessels expanded, the result is a softness of the parts and a maintenance of even thickness; for the size of the vessels makes up for the decrease [caused by expansion]. The vessels therefore are expanded in agreement with every ratio of the expansion of the uterus; and thus the thickness of the latter is the same during every moment of its increase in size. For this reason some have supposed that the uterus is a purely vascular and pulpy structure (see Boerhaave [n. 225]), although there is also some admixture of nervous fibres, as well as of ducts from the peritoneum, and, moreover, certain motive fibres, which seem to be fully formed only in gravid women and which afterwards disappear.

282. *That no blood of an alien quality, nor in a quantity greater than is meet, should break into this sacred abode of the novel embryo with ungracious burdens, innumerable insertions and conjunctions of the arteries with the veins are provided, and more capacious asylums of refuge and as it were sinuses are formed. These also open into the cavity of the uterus in order that all the refuse portion that comes down into the uterus may be everywhere absorbed, and that this hospice may be continually and thoroughly expurgated from all such external annoyances. To this end divers paths of discharge are provided,—namely, into the great veins of like name with the arteries, that is, into the internal iliacs; also into the liver by the internal hemorrhoidal and so by the mesenteric veins; likewise into the pelvis and the cellular tissue of the peritoneum of this lowest region. Thus all the residual portion secreted from the arterial blood is sent out distinctly by its own passages.* In this way every chance contingency is provided against. Therefore there are intercommunications between the veins just as between the arteries; and the veins are greater in number and larger in size. That many serosities are derived towards the uterus and flow into it from the extremities of the arteries, is a fact confirmed by experience, by the changes of state occuring in the body and animus of the pregnant mother, and by the increasing motions and inverted positions of the embryo. For there is then no outlet through the cervix and internal orifice of the uterus, this being entirely closed; nor is it probable that there is at this time any transpiration through the Fallopian tubes; and therefore no other way is opened for this excrementitious sweat except into the venous sinuses or the veins themselves which, according to the experience of Heister and other anatomists, open into the uterus with gaping mouths [n. 217]. For this reason the veins are greater in number and larger in size than the arteries. But how the venous blood is drawn off by distinct passages according to the differences of quality, is a point that has not yet been unravelled.

It is clear that the spermatic cord[1] in women has similar venous ramifications as in men, and that these in like manner carry off the residual portion towards the emulgent vessels;[2] likewise that the hypogastric veins lie in this situation. It is also clear that the round ligament is a kind of continuation of the spermatic vessels, and is furnished with innumerable vessels running within the enclosing tunic of the peritoneum; and that it passes through the rings of the abdominal muscles towards the pelvis and there affixes itself to the fatty membrane under the clitoris. And further, it is clear that the blood of the hypogastric ramifications runs into the bifurcation of the vena cava; and likewise that branches of the hemorrhoidal veins return blood into the liver, where it is again purged. But how all these streams are carried back [by distinct paths] according to the different natures of the blood, has not yet been discovered. It is not, however, to be doubted that the distribution is such that each branch carries off its own particular quality of blood; for all the branches are intercommunicant; nay, the veins of the ovaries communicate with those of the Fallopian tubes, and the veins of both with the veins of the uterus; nor can it be doubted that these vessels form marvellous contortions. That there is a similar unloading of lymph from the peritoneum is evident from the insertion of the broad ligaments at the pelvic bone, and of the round ligaments in the adipose tissue at the same place; and also from the communication existing between the outmost tunic of the uterus and the tunics of the above mentioned ligaments.

283. *A similar application to that in the uterus may be formed in the Fallopian tubes, and even in the abdomen itself; hence come tubal and abdominal fetuses.*[3] *For there is a kind of absolute communication of all the parts with the uterine vessels. These applications, however, are not attended with the same progress and success as the applications that occur in that abode which is as it were their native home; that is to say, in the uterus, which is exactly fashioned for this use.*

284. *That the uterus accommodates itself to all the offices*

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[1] *i. e.* the cord formed by the vessels that supply the ovary, see n. 250, 279.

[2] The renal veins.

[3] See App. n. 5.

requisite for the formation of the new mannikin before he begins to live from his own life, spirit and blood, is evident, not only from the change of state which comes over the bloodvessels both arterial and venous, and from the resultant softness, expansive faculty, and constantly similar thickness [*of the uterine walls*], *but also from the situation of the uterus between the bladder and the rectum and above the pelvis, which, by reason of this use, is very ample in women, as are also the ossa innominata and the other neighboring parts of this region. By virtue of these provisions the embryo resides in this abode with the utmost safety, and, moreover, has the opportunity of expanding in due measure, that is, of enlarging its body to the proper dimensions.* Thus all the external parts are so adapted by their very nature, that the uterus is laid up in the safest place, and in fact between the bladder and the rectum; which has given some anatomists a handle for their teaching that we are born between urine and dung. Of the application of the vessels and the resultant expansion and softness of the uterine substance, we have treated above [n. 281]. *Moreover, on one side the uterus is perfectly free, and when expanding in the abdomen can be determined whithersoever need requires. Its ligaments, which are four in number called the round and the broad, are no hindrances to this expansion, but favor it in every way; for they are clad in a tunic continued from the peritoneum; and that the peritoneum, and consequently all its appendages, by virtue of its cellular structure, is capable of considerable extension, is clearly evident in fattened animals. Again, the connection with the broad ligament is so loose that when the uterus swells up, this ligament is rather relaxed than constricted; so likewise the ligamentum teres or round ligament; nor is the latter much stretched beyond its usual size. The ovaries and Fallopian tubes completely yield, and draw near to the uterus, and thus make room in the abdomen.* That the expansion is directed forwards and a little upwards where the uterus is free is proved by ocular experience. The broad ligaments and alæ vespertilionum then yield, but are not constricted. It is the round ligaments alone that regulate and limit the position of the uterus in the abdomen. For soon after leaving the uterus they run out through the rings of the abdominal muscles and are attached to the adipose tunic; and therefore they are placed in the corners of the fundus; but still they give way; for they are enveloped in the beginnings of the broad ligaments and of the ligaments of the ovaries, and there form a duplicature which at the time of pregnancy appears to be obliterated. Provision is thus made that none of the other viscera shall trouble the uterus by any pressure, and that, on the other hand, the due rights of the several parts shall be maintained.

285. *In order to the right performance of these several operations the uterus is seen to have a threefold motion, namely, its two ordinary motions, that is, the pulsatile motion of the arteries, and the expansive and constrictive motion of the abdomen, and also an extraordinary motion which arises from the different changes of the embryo by means of the muscles of the uterus and placenta.* That it has a pulsatile motion cannot be denied, since so great an abundance of arteries and of blood meets within it. That it has also an alternating expansive motion is plain from the continuous connection of its common coat with the peritoneum and the several processes thereof, and also from the insertion of the round ligaments into the rings of the abdominal muscles, that is, of the [internal and external] oblique; for with every turn of the respiration, the muscles alternately dilate and constrict the abdomen, and this effect cannot but be continued on to the uterus. The extraordinary motions also are perceptible, as when the hand is laid upon the pregnant abdomen; and Ruysch mentions a similar motion after birth [n. 231]. That by means of the muscles this motion is communicated to the very substance of the uterus, is a consequence following from the connection of the parts.

286. *That the several operations may follow each other in due succession, the uterus is diligently guarded from every external injury, nay, also from the inconstancies of the ultimate world, and particularly from the air and the inconstancy of its forces, so that nothing from without may burst in and disturb this most noble work, and that all things from within in their progression from inmosts, may succeed each other according to the order of nature, and be subordinated while they are being co-ordinated. For this reason the cervix of the uterus, and that orifice called the internal os by which it is terminated, is completely closed up by virtue of its* *connection with the whole fabric of the uterus, and also by a viscid humor of its own.* Something of this may be demonstrated from the very fabric of the uterus, that is to say, when all the vessels and all the forces are concentrated towards the placenta. The effect is quite evident; for when the orifice is closed the cervix also is closed, the communication between the valvulæ conniventes and the folds, being of such a nature that when the circular and oblique valves are constricted, the longitudinal, which are as it were peduncles and trunks to the circular, are also constricted. Moreover the cervix and the internal orifice are furnished with a number of corpuscles, from which as from so many little springs issues a humor; these corpuscles which are also called glands, vesicles, hydatids, have been described by many anatomists. This humor, which is as it were glutinous, completely blocks up these cavities thus constricted of themselves; as experience proves.

287. *This same blockade of the lower part of the matrix is a careful provision against the possible existence of any new conception, and thus of superfetation. By the closing of the cervix and at the same time the expansion of the uterus, the whole passage leading from the cervix to the ovaries is entirely closed.* For when the internal orifice of the uterus and the tube of the cervix are closed, there is no longer any passage open into the vesiculæ seminales which lie there in groups, and which open when the tube of the cervix opens, see above [n. 240, 246]. Moreover, by the expansion of the uterus, the vasa deferentia or ligaments of the ovaries are also constricted, since the fold of the round ligaments is opened out. Thus in this way also the vas deferens is rendered useless; and as a consequence, the ovaries, which are now retracted towards the body of the uterus, cannot be impregnated. Nor can the Fallopian tubes be any longer applied to them, nor even expanded and inflamed; for the whole determination, both of the blood and of the spirit, is now directed towards the placenta. Thus the natural order such as ought to obtain at the time of conception, is entirely changed; see above [n. 271, 274]. *As regards further particulars respecting these and other offices of the uterus we shall learn them more effectually from a consideration of the progress of the embryonic formation; that is to say, in* *the chapters on the Placenta, the Umbilical Cord, the Amnion and Chorion, or the Secundines, and the Birth itself; for the uterus is formed for the sake of all these.*

288. *All the differences mentioned above as existing between the female sex and the male, spring from one single end and principle, namely, that the female shall represent the passive force, and the male the active, and that thus the two forces taken together shall constitute a kind of unit, and from this union shall beget a third and similar being. This is the very principle, and consequently the very end of the* [*differences between the female sex and the male*], *and it is from this source that all the varieties that occur in the two sexes derive their origin; for as is the end such are the means and such the effects, which completely correspond to the ends; and therefore, as is the soul, the rational mind, and the animus, such also is the external form of the body. This is the reason why from the face and eyes we know what is going on in the animus and mind.* But these are matters of psychology, and therefore I do not dwell on them; still every one acknowledges the truth of what has been said. That woman represents the passive force, or is, as it were, form, while man represents the active force, or is, as it were, essence, has been shown above [n. 208, 213].

289. *From this principle and this end it follows that the fibres of women, and particularly the organs which are the beginnings of the fibres, are less active and more passive* [*than those of men*]; *and hence that their fibres are more tender and soft, ready for every change of the animus, more lax, and more prone and adaptable to the transmission of the spirit. For the fibre is governed by its animal spirit, and as is the spirit, such is the animus; or rather, as is the animus, such is the fibre, and as is the fibre such is the whole organism of brain and body, which latter consists wholly of fibres and bloodvessels, the latter of which again, are also fibres, but in the last degree of composition. Therefore, as is the fibre, such is the whole organism of the body; as then is the organism of the body, such is the outward countenance and expression. Therefore, in woman there is greater tenderness, patience, and beauty; and in her beauty shines out the fact that she bears the passive faculty and not the active,—which latter presents something of harshness and resistance.* These positions follow as consequences and conclusions from the single principle mentioned above. That in the body there is nothing that determines the real form but the fibre, will be shown in the Transaction on the Fibre.[1]

290. *Such being the condition of woman relatively to man, it follows that she is endowed with recipient, passive, and at the same time, reactive organs; for what is passive must also be reactive, otherwise there is no limit to the activity, nor can anything exist as a substance* per se. *From these first and middle causes proceed those innumerable characteristics in the two sexes, which though diverse are yet conformable to each other; the characteristics namely: That women are more prone to be excited to changes by the external senses. That relatively to the violence of the affections of the animus, they enjoy less judgment, in that they regard ends at a remote distance, and the more present ends to which the affection of the animus incites them, as being veriest rational ends. That they enjoy a more lively imagination than men, and that their rational mind, which is the superior animus, acts chiefly as a passive and reactive force, and descends with much persuasion into the imaginary fancies of the lower animus. It is different in the male sex, which is more in the enjoyment of the rational mind and of its active force, rather than its reactive; in such way, namely, that the man not only rules over the affections of his own animus as over servants and forces of a lower order, but rules also over his married partner, who possesses not an active but a passive force of will; and therefore it naturally follows that in all matters that concern rational ends, the woman is subject and yielding to the decisions of her husband. Lastly, it follows that, as regards the body in particular, woman is more prone to those emotions to which her animus is excited by external objects, and rushes at once into actions lest her desire be controlled; consequently that in her, are more readily excited all those fluids which, as means, move the affections of the animus; namely, the bile which moves to anger and wrath, the heat of the blood, and also a certain seminal humor; not to mention other liquors. For this reason also women have more numerous external excitements than men; for ultimates correspond to firsts through mediates. Hence also it follows that women sooner arrive at maturity, namely, within*

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[1] See the FIBRE n. 314–316.

fourteen or fifteen years, while men require a longer period; for the more the inmost human faculty prevails, the later is the maturity; and on the other hand, the more the exterior powers prevail, the quicker the maturity. For in the latter case the fibre is sooner prepared for supplying its nutritious juice; which is not the case where later progress is made from inmosts. This is the reason why brute animals, which enjoy no rational mind, mature within a few years after birth. From this same principle it also follows that women, arriving at maturity more quickly than men, also come more quickly into such a state that they are bound to send off a superfluous portion of spirits and blood; for it is the superfluity that is expended naturally upon the genital organs, and since women are excited more by the animus than by the mind, it follows that their blood is more contaminate, and, by means of the menses, needs more abundantly to be purged. For the more one is ruled by the pure rational mind, the purer is the spirit and blood of which he is possessed. All nature commences from inmosts and passes to the extremes; that is to say, she commences from centers and passes to surfaces; and therefore the blood that is on the surface, if it be rightly disposed within, is not so easily defiled, but dispells heterogeneous elements by its own proper and inherent force. From these considerations it is apparent why women are passive, not only in physical acts but also in moral, whereas men, from their very nature, are active; from which reason also it is that women are more beautiful and tender, and in the very passivity of their disposition are as it were graces; and furthermore, that in every matter of decision they are more prone and determinable than men, and in every surface matter appear more intelligent. The genius of the age consists in our excelling in the power of imagination, and in our rational mind being merely passive and reactive in respect to the objects that come in through the external senses. On the other hand, the activity of the rational mind, and its resistance to the affections of the animus, that is to say, its exercise of a dominating power, is not esteemed at this day as a token of character, and scarcely as a token of judgment. This is the reason why men cannot fail to be subject to women, for this is favored by the consent of the majority, which is the voice of the age.

CHAPTER XV

The Placenta.

291. Heister. (*Compend. Anat.*) The placenta was called by the old writers the uterine liver. *Number:* In women the number of placentas corresponds to the number of fetuses, but in cases of twins the two placentas are often grown together, though their vessels do not appear to intercommunicate. In many animals, however, especially cows, numerous placentas are found, sometimes as many as a hundred for a single fetus; in which case the placentas are termed cotyledons. *Figure:* The figure of the placenta is orbicular, about eight or nine inches across, and one inch thick. *Connections:* The convex and spongy portion adheres to the uterus by the intervention of a very fine reticular villous membrane[1] continuous with the chorion; while the concave side, which receives the fetus displays many and ample bloodvessels and is joined to the umbilical cord, is surrounded by the smooth membrane of the chorion and amnion. *Situation:* It has no fixed and constant situation in the uterus, though it is generally attached to the fundus; in which situation Ruysch not long ago thought he had discovered in puerperal women a new muscle consisting of spiral fibres. It has been frequently found also in the posterior part of the uterus. *Substance:* According to the majority of more recent writers, it is glandular, being made up of innumerable small glands, which, however, are invisible; therefore it is better described by Ruysch as a vascular substance consisting of nothing but vessels, namely, the umbilical arteries and veins most delicately ramified and interwoven. (n. 242.)

292. Is there a circulation of the blood between the mother and the fetus? Many deny this, or at any rate call it into question. Cowper found that mercury injected into the umbilical arteries of the fetus entered the veins of the uterus of the mother. On the other hand, Vieussens observed that mercury injected into the carotid arteries of a pregnant bitch, ran down, not only into all her members and viscera, but also into the whelps enclosed in her womb. Heister relates that in the body of a puerperal female who died of hemorrhage of the uterus, he found no blood in the fetus, either in its heart or in its larger vessels.[1] The reciprocal circulation between the mother and child is affirmed also by Rauholt, Morgagni, Salzmann, and others. (Nota 36.)

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[1] The decidua placentalis, a development from the internal or mucous membrane of the uterus; see n. 312, note.

293. Bartholin. (*Anatome.*) The placenta is of a circular shape, but the circumference uneven. I have observed in it five prominences at regular distances from each other, with the membrane of the chorion thicker in the intermediate spaces. At the place where it is turned to the uterus, the placenta is rough and wavy like bread that has split in the baking; and when this convex part is cut into, it presents an infinity of fibres which may be traced to the trunks of the veins. The placenta is thicker in the middle of its little eminences, but becomes thinner towards the extreme borders, as is also the case with its capillaries, which are interwoven with a variety of texture. The arteries and veins ramifying through it, gradually become smaller about the margins, and form remarkable plexuses. I have noticed of the veins of the placenta, that the contained blood could easily be driven, either with the finger or with an instrument, towards the cord, but not so easily towards the placenta. The contrary was the case with the arteries, which, under pressure of the fingers, send the blood to the uterine liver[2] with the greatest ease, but to the cord with some difficulty. The placenta by its little veins, sucks the maternal blood mediately from the veins of the uterus [prepares it, and attempers it for use]. A part of the blood returns to the placenta through the iliac arteries of the fetus. (Lib. I, Cap. xxxvii, p. 304 *seq.*)

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[1] This was a case of twins, one of whom was safely delivered before the occurrence of the hemorrhage. The dissection, and the examination of the remaining fetus, was made a few hours later.

[2] Uterine liver, that is, the placenta.

294. BOERHAAVE. (*Instit. Med.*) The ovum applies its convex surface to the concave surface of the uterus with which it everywhere unites by the emission and reception of vessels of the most delicate kind; chiefly, however, in the situation of the little placenta, where, rising to form an uneven tubercle, it insinuates itself into the ample hollows of the distended uterus. In proportion as the channels of the ovum increase, so also the emissary vessels of the uterus are dilated.—The umbilical cord consists of two vessels which conduct humor from the fetus into the placenta, and of one larger vessel which leads from the placenta into the fetus.—*But when this mutual enlargement of the mouths of the vessels has increased to such an extent that the internal emissaries of the uterus can now send forth the blood itself, and the other vessels receive it, then the abundant blood contained in the large arteries of the uterus, and driven against the uterine placenta, seems to be impelled into its dilated vessels, to undergo an alteration in its substance, and to be transmitted to the fetus.*[1] This seems to be proved by the hemorrhage which takes place in abortion, in delivery, in wounds of the gravid womb or of the womb during labor and the separation of the placenta; also by the loss of blood in the fetus when the mother only is wounded. On the other hand it seems to be opposed by the non-appearance of the vessels in the dead body, and by the unbroken entirety of the membranes that gird the surface of the placenta contiguous to the uterus, rendering it smooth and polished. (n. 676-678.)

295. The body of the placenta consists principally of innumerable arteries distributed in all directions; of veins intertwined therewith by the same distribution; of lymphatic follicles; and of lymphatic vessels. Moreover, it is surrounded by a fine membrane,—which, when the recent placenta is gently squeezed, exudes from an infinite number of oblique little openings a dew of blood and drops of other humors, the oblique vessels themselves being discernible by the microscope, —given off by the chorion over the convexity of the placenta, where it joins the uterus. [The placenta, therefore, is situated between the unfolded membranes of the chorion, and is covered by the chorion on both its surfaces.] It receives two arteries, which bend back from the end of the descending aorta, go to the umbilicus of the fetus, there pass out, are supported in the semi-cartilaginous substance of the umbilical cord, and carry back from the fetus the less suitable blood. The origin of the veins, however, is so subtle that it is not to be discerned at all; still they are all ultimately collected to form one trunk, which passes into the umbilical cord. (n. 679.)

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[1] The words between the asterisks are not quoted by our author, who instead, sums them up by saying, "That the blood circulates from the fetus to the placenta, seems to be proved," etc.

296. SCHURIG. (*Embryologia.*) Schurig relates an experiment made by CHARLES RAYGER and LOUIS GAYANT with the view of ascertaining the mode of the blood's circulation in the embryo. In a full grown fetus that had been born dead, they first blew air through a little tube into the umbilical vein, which had been previously opened for the purpose; the air returned through an opening in the umbilical arteries, having first produced intumescence of the substance of the liver. Then, for the sake of greater certainty, a blue liquid was poured in through a syringe; in a short time this liquid first expelled a cruor from the arteries, and afterwards itself came out. CRAANEN: Thus we see that the veins in this part perform the office of arteries, and the arteries the office of veins.—FRED. HOFFMAN: It is worthy of note that liquid injected by a syringe through the umbilical arteries returns through the umbilical vein; showing that there are no anastomoses between the vessels of the uterus and those of the secundines and fetus, and that the blood of the fetus does not return again to the veins of the mother. RUYSCH concludes that the uterine bloodvessels are not united immediately to the vessels which make up the placenta, but that the cohesion of the two is effected by the intervention of a certain membranous substance (I. iii. § 7, 8). WILLIAM COWPER says that mercury thrown into the hypogastric artery of the mother, flows back through the umbilical vein of the placenta; but when injected into the artery of the placenta, it regurgitates through the hypogastric vein of the mother. (§ 10.) RUYSCH: The bloodvessels constituting the placenta are never united with the uterine bloodvessels; nor is there any gland, however small, found in the placenta. The whole placenta is made up of bloodvessels, whereby the chorion, amnion, and umbilical cord are all connected with each other. To these add the membranous muscle lately discovered by me, and which is connected with the inner surface of the placenta, that, namely, which is affixed to the uterus. The whole body of the placenta consists of nothing but bloodvessels, the ends of which go to form little vascular brushes.—The placenta is easily lacerated on the surface which faces the uterus; and when lacerated it is divided into various little globes as it were. [I have many times filled the bloodvessels which constitute the chorion, with a red waxy injection, so that if anything was to be found in the placenta excepting bloodvessels, it would have come to view; but I have never found anything but bloodvessels. To discover whether the placenta is united to the uterus by the extremities of the bloodvessels constituting the placenta, I have often filled those vessels with a red waxy injection, and have found that the placenta is covered not only by the chorion, but also on the side facing the uterus by an analogous membrane which is firmly attached to the extremities of the bloodvessels. It is hardly separable from the placenta, and seems to be similar to the chorion in substance. It can scarcely be seen without previous injection; but by injection the whole placenta appeared ruddy, while the membranous substance was white or gray,—and this along the entire surface where the placenta is attached to the uterus.] Ruysch concludes from his wax injections, that the uterine bloodvessels are not immediately united with the vessels of the placenta, but that a cohesion of the two is effected by means of the above mentioned membranous substance.—The peculiar membrane that covers the placenta is called by Ruysch, the juicy membrane. Thus far Ruysch. A number of quite conspicuous fibrils come off from the chorion and are implanted like roots in the uterine tubules [which proceed from the arteries. These fibrils, combined with the tubules, grow daily larger and more ample, and later they constitute the placenta]. (§ 15–17.)

297. Ruysch. (*Observ. Anat.*) In many women [when the secundines have failed to follow the birth of the fetus] the abdomen is distended to a great size and this is attended with difficulty of breathing, swelling of the feet, anorexia,[1] a feeling of oppression in the chest, swoon, and pallor of the face. It is not uncommon for the placenta to remain in the uterus ten months or more after the birth of the fetus. In such cases placentas sometimes degenerate into hydatids or vesicles hanging from footstalks and filled with aqueous humor. These are not moles [although they are so regarded by ignorant midwives]; for [after the expulsion of the fetus and its humors] the placenta is contracted by the uterus into different shapes so as to resemble moles. The placenta hardens from prolonged delay in the uterus. Ruysch shows four figures, in three of which the placenta is all over clusters.[2] (Observ. 28, 33.) When the cord is inserted precisely into the center of the placenta, it comes away for the most part with great difficulty; but if it be implanted more to either side, it readily and indeed spontaneously follows into the world after the birth of the fetus. (Obs. 97.)

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[1] Anorexia is an affection of the stomach which produces a loathing for all food. It may or may not be accompanied by nausea.

[2] The first of these figures shows a placenta, part of which has degenerated into a substance resembling flesh, and the rest into large egg-shaped hydatids, which lie on its surface in thick clusters. The two remaining figures show different parts of a single placenta which has almost entirely degenerated into hydatids. These are somewhat pearshaped, and hang like thick clusters of grapes, suspended from a single stem.

INDUCTION.

298. *In the whole nature of the three kingdoms we meet with nothing more worthy of investigation, or more wonderful, than the formation and as it were new creation of man in the womb. It is like the existence of a microcosm in the macrocosm, or like the sending forth of a new system, and as it were a new planet, from its ovum and its principles.* Every individual animal kingdom may not inaptly be compared to a world; for we are like planets careering in their great vortex or universe, which latter constitutes the planetary society. The laws also of the universe are the same in both cases. Each orb is governed by, as it were, its own tutelary deity, and each has its own soul to rule that particular world. But this is a comparison, into the details of which we cannot fully enter.

299. *This new animated world now coming into existence, when it has passed from its most secret places, that is, from the ovaries through the windings of the Fallopian tubes, and has finally arrived at the fixed abode, that is, the mother's womb, where it has decreed to pass its first life, attaches itself to the wall of the cavity, and this exactly in the spot whence it can look around upon the whole parental macrocosm, and can feed upon and command for itself and in the utmost freedom, all the spirit and blood that can possibly be required in the work of formation. For whatever the macrocosm carries, this the embryo can lay claim to as its own property.* To this spot all the bloodvessels, that is, the arteries and veins with all the blood of the mother's heart and arteries, and also all the fibre with the spirit of the whole cerebellum, come together in confluent streams. And therefore the embryo can here take up whatever of quantity and quality it chooses; see above, n. 274, 278, 279.

300. *In order that it may draw out with the utmost freedom the spirituous essences of the mother's blood, may claim them as its own and appropriate them, therefore from its first stem it sur-*

rounds itself with a general covering,—a covering which is acquired, and is not proper to itself; that is to say, with the double membrane of the chorion, and also with the amnion, and furthermore with a fluid expanse; and it applies the points of this covering to the uterine sinus, and interposes a placenta by means of which, with wonderful power, it extracts from its great mother or macrocosm whatsoever it has need of. On this subject see below. *From this placenta it puts forth an axis or umbilicus, which it conveys through the most tranquil region of its sphere, all the way to the liver. Thus there are two foci, navels, or bosses, as it were, which, being joined together by the fluent and tortile axis, have a mutual regard each to the other. Thence it proceeds on its liquid way to the first court of its world, that is to say, to the right auricle of the heart. From here it goes to the inmost shrine or court, that is, to the sacred and spirituous palace of its heaven, and to its very penetralia, that is to say, to the brains. From these, by the path of the veins, it again returns to the above mentioned court, namely, to the left chambers of the heart. Then, together with the fibres of both heart and brain, it runs through the common and royal road of all, to the termini where the way divides into two. From this point it betakes itself back again to the axis or umbilicus, and by a tortuous path returns again to the placenta, and meets its beginning.*[1] *Here it finds spread out before it, a field most ample, which determines and limits the sphere of the vortex, namely a membranous and a fluid expanse,—the former being called the chorion and amnion, and the latter the liquor amnii.* These points must now be taken up one by one.

301. *The placenta is the means of union between the gestating mother and the enclosed fetus; but the extension of this union is effected by means of the tunic called the chorion, through which a wonderful circulation is carried on; to the end, namely, that the purer blood poured through this circle and periphery, may still look to its first and last termini in the placenta, and, by means of the placenta, to the inmost parts of the embryonic body which lies enclosed in the membranes.* The outmost tunic, called the chorion, is irrigated by innumerable bloodvessels, which can come from no other source than the surface of the placenta, or the tunic that surrounds the placenta and is applied to the uterus; for the chorion surrounds the whole placenta and is attached to the uterus. Into this tunic, there is no other entrance for the bloodvessels, except by way of continuation from the same tunic that environs the placenta. The fact of the continuation is established by ocular evidence and by universal consent. The blood which irrigates the chorion can be discharged nowhere else than into the vessels of the placenta; for no other place of discharge is provided,—as is proved beyond question by the necessity of the case as based on the continuous connection of the parts.

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[1] The subject of the fetal circulation is dealt with in detail by our author in a special chapter in 1 E. A. K., 316 *seq.*

302. *The placenta lies in a duplicature of the chorion; and therefore it follows, that the bloodvessels congregated within the placenta, and also the vessels of the chorion, must for the most part run a course within the same duplicature. Something similar to this seems to have existed as an analogue of it, in the very ovum while still undetached from its ovary from which it is afterwards torn away; but then, instead of blood, it would seem that purer, that is to say spirituous essences flowed through it in a still more perfect manner, and accomplished an almost similar circle.* That the placenta lies in a duplicature of the chorion, is proved by that tunic itself, in that it surrounds not only the anterior but also the posterior surface of the placenta. Moreover, it is also evident that the chorion is a double tunic, being in this respect not unlike the dura mater which encloses in its duplicature the great venous sinuses, and in the same duplicature, receives the arteries and veins proper to the brain. Similar duplicatures are also frequently found in other parts of the body. So long as the ovum resides in its ovary, it is set about by a kind of finely intestinal corpus luteum as by a most delicate womb; but whether there is here any trace of a placenta is not yet clear; from the connection of things, however, it would follow that there is some analogue thereof, and that the petiole is in place of the umbilical cord; and also that in the earliest stage of conception, something is visible between the tunics which is like the first thread or stamen of the fetus. That this rudiment [of a placenta and cord] penetrates even to the interiors, is a point the truth whereof will appear as we proceed. The tunics themselves remain; for in process of time they grow larger and thicker; whence it seems scarcely possible to doubt, that something similar [to what occurs in the chorion] occurs here in a more perfect way; and that what time the tunic is not pervaded by the red blood, it is yet pervaded by its prior essence or spirit, which runs through its circles in a more perfect way,—as will be shown in the Doctrine of Forms.[1]

303. *By means of the placenta and chorion there is given a communion between the mother and the embryo, though not such as exists between the appendages, members, or viscera of one and the same body. For the mother and fetus are at once conjoined and separated,—the mother being a substance by herself and the embryo by itself. And whatever of blood and spirit the mother possesses, is, as it were, not her own property and possession relatively to the embryo; which takes from it whatsoever quantity and quality it requires. But on the other hand, whatever the embryo draws from this great mother, it claims as its own property and possession, and leaves it at the mother's disposal no longer.* The communion between the several viscera of one and the same body is of such a character, that whatever one member possesses is common to the rest when they need it; for all the blood, wherever it goes, flows back finally into the great vena cava, and so towards the heart. Not so however in the embryo, in which no such reflux has as yet been established by any positive observation. One might indeed conjecture its existence on the ground of certain phenomena, namely, the evacuation of blood from the embryo when the mother has been the subject of violent hemorrhage [n. 292, 294]; but that this is not a consequence of any such reflux, will be established presently on many grounds. *Such therefore is the union, that the embryo claims for its own whatever the mother possesses; and when once it has drawn it in, it claims it as absolutely its own right and possession. But the mother claims nothing as hers that has once become the embryo's, nor asserts any further right of property in it; but it passes from the power of the one into that of the other. Thus from the very first the jurisdictions of the two are separate. This is sufficiently apparent from the fact of the insertion of the*

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[1] See the FIBRE, n. 319 *seq.*; *cf.* also, as to the petiole, above, n. 251a, note.

fibres, vessels, and ducts of the maternal uterus, into the tunic of the placenta, which freely draws in the sanguineous fluids, but so inclines and obstructs its paths and their pores, that it can no more send the stream back through the same ducts. This is sufficiently evident from the extraordinarily fine injections of Ruysch and other anatomists [n. 292, 293, 296]; for when the arteries or veins of the placenta were injected, the surrounding membrane contiguous to the uterus was in no wise tinged by the color of the injection, but rather became pallid and smooth; so that it has not yet been found that a single drop escaped through the pores of that tunic. This is a very evident proof that these bloodvessels, or vessels purer than bloodvessels, pass through the tunic quite obliquely, as is the case in the intestines and other parts, thereby permitting entrance but no return. Ruysch bears open witness to this fact when he says that the vessels of the placenta communicate in no way with the vessels of the uterus [n. 296]. Therefore, whatever of blood the embryo has drawn, it claims as its own property, and does not restore to the mother. The same is also proved by the changes that the mother undergoes during the time of gestation; such, for instance, as the feeling of oppression in the chest, anorexia, swoon, pallor of the countenance, and like effects. Whatever then has once been received into the placenta is given up to the growth of the embryo. *It is, however, provided that the embryo shall draw from the mother no more than she is able to replace.* Otherwise the birth of the one body would mean the wasting away and death of the other, and, like certain animalcules, the mother would spend her own life upon her offspring.

304. *During the first days of conception the embryo demands pure spirit from the blood and fibres; but afterwards, spirit mingled with grosser essences,—which we shall henceforth term the purer and white blood; and lastly, blood, and a certain suitable serosity,—all according to degrees, as the body grows, and demands for its use, grosser aliments in addition to the purest.* This is plain, not only from anatomy, that is to say, from the state of the ovum in its ovary, but also from the uterus itself to which the placenta is attached. For the vessels successively enlarge, showing that not only a larger quantity but also a grosser[1] quality is demanded; for the purer the vessels the more refined is the blood that they carry, since clots and the viler serosities are dissipated on the way to the capillaries. Reason also confirms the same position; for the thicker the web becomes, the grosser are the threads, and the grosser the fluids that permeate them. Furthermore, it is confirmed by the phenomena in pregnant women, such as lassitude, anxiety, changing emotions, and also slight bodily ailments,—all of which observe the same successive order, proceeding successively from things inmost and purest to such as are grosser. Moreover, both in the Fallopian tubes, and finally in the uterus, the organs to which the ovum is attached, are of the same structure as the corpus luteum, which is the first womb of the ovum, and can be permeated only by the purest blood and its spirit. *For everywhere in her kingdoms nature passes in successive order from inmosts to outmosts, or from purest things to grosser,—and this, not only in the formation of her parts, but also in the parts themselves when formed.* Hence comes the perfection of nature's works and actions; for she proceeds from the purest parts, which are also the most perfect, to those that are grosser and more imperfect, and these she then rules from the inmost and most perfect. The reverse is the case with human art, which proceeds from outer things to inner, but stops at the very threshold, that is to say, in outmost things. It should also be observed, that when nature emulges and draws out the grosser parts, she at the same time emulges and draws out parts that have once been purer; that is to say, all the parts whatsoever, from the prior to those ultimate, that are simultaneously enclosed. For what is interior is contained in what is proximately grosser, and the blood, which is the last of the animal humors, contains in it whatever has preceded. For such is the order of fluids, that the purest essence comes first; next to this comes the spirit called the animal spirit, and the white blood, and lastly, the red blood. When the embryo draws out spirit, it simultaneously draws out what is prior and purer, that is to say, the verimost vital essence; and when it draws out blood, it also simultaneously draws out spirit, and in the spirit again, the essence just mentioned; for these fluids lie in the blood simultaneously, and are inseparable from it. They are distinct, because the prior essence has a separate existence apart from the posterior, but not the posterior apart from the prior, inasmuch as it exists from the prior, and not *vice versa*. Thus the first rudiments of the embryo cannot be formed from mere blood, but the formation is effected successively before it exists simultaneously; for every entity co-exists from things successive.

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[1] The Latin has *melior* (better), but the context indicates that this is a mistake for *crassior* (grosser).

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305. *In the succeeding period, however, the embryo itself conceives and excludes from its own principles and first springs of life in the two brains and the two medullas, its own spirits, and finally its own blood, by their own degrees; moreover, it also nourishes itself from the store it has in the meantime been laying up. Hence the need and necessity for food and nutrition from the mother's blood becomes gradually less; and so* pari passu, *the communion begins to perish, and the embryo to live from its own life without auxiliary aid from the life of the gestating mother. From this cause, now first advances from the inmost parts of the fetus an effort and a secret longing to break connection with the mother, and to claim the right of its own disposal,—to which endeavor the outmost parts conspire. Wherefore the embryo then attempts to open the doors, and to desert its tunics, the chorion and amnion, and also its placenta, which now begins to be of no further use.* This will be demonstrated more distinctly in what follows. The cortical glands of the brain are little factories of the utmost degree of purity, which compound and exclude that purest of animal essences, the animal spirit, and transmit it through the fibres into the vessels, where, by a sort of copulation with the sulphureous and saline elements of the same degree, the blood comes into being. It derives these elements partly from the mother and partly from the liquor amnii. Thus it no longer stands in need of any foreign resources.

306. *From these various considerations it is apparent that the first essence, which, regarded as a substance is the soul, is derived from the father; that it conceives and excludes itself according to the increments of the purest organs of the brain; and that all the* *rest is from the mother. It is also apparent that the ovum cannot in any wise be impregnated by the soul and spirit of the mother; for in order to conception, it is requisite that this first essence shall be pure, and shall be compacted as it were into globular forms in order that it may occupy the inner place while the animal spirit occupies the outer, that is, makes up the surface. This effect can be attained only in the male, who possesses organs similar to this office, that is to say, testicles which extract that first essence, and epididymides which fashion it.*

307. *The uterine arteries of the mother appear to extend their pulsation or sphere of activity no farther than to the first point of contact with the placenta and its outmost membrane the chorion; so that the mother cannot be said to act upon the enclosed fetus, but only to proffer it spirits, blood, and humors, and thus give it the faculty of acting for itself.* This is plain from the very connection of the vessels and ducts of the uterus with the placenta; for there is no immediate connection with the vessels of the latter, but only a mediate connection by the common tunic or chorion, which in this situation is pulpy, soft, and bibulous. The mother is the macrocosm or that universal subject from which the fetus draws all the necessities of its life; and the influxion of universals into those things that are at once distinct and separate, is always of such a nature that it simply gives power,—all the rest depending upon the recipient subject itself. On these subjects see our Doctrine of Order.[1] *Thus the placenta with its common membrane the chorion, applied as it is to the uterus, is of an epispastic or attracting nature, like blister-drawing and detersive substances; much in the same way as the mammæ and the nutrient papillæ after birth, which do not pour in the milky fluid, but merely proffer it to the infant, to be sucked out.* This is confirmed not only by the fact that the vessels of the placenta do not communicate with the uterine vessels, according to the observations of Ruysch and other anatomists [n. 296], but also by other phenomena. Were the blood poured in, then the embryo would receive whatever the mother brought to it, whether clean or unclean; and hence the fetus would not direct the work nor emulge only what is conducive to the formation of its delicate frame. Thus its growth would not be limited to the stated period of nine months, but would depend upon the prodigality of the mother's supplies; and thus inconstancy would preside over the several periods of its formation. But it is the embryo itself that thirsts and hungers for food, that is to say, for a precise quantity and quality of the maternal food; and all proceeds according to this natural hunger and thirst, just as, after the delivery, at the teats of the nursing mother, when the same instinct is active, constant, and repeated.

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[1] See n. 131, note.

308. *Meanwhile, the mother has it in her disposition, that all shall be done in order, and this by the interposition of fibres, including motive fibres, between the walls of the uterus and the tunic of the placenta; and also by the application of ducts, according to the attractive force of the placenta.* This appears to be the cause of the fibres of the orbicular muscle mentioned by Ruysch [n. 216, 296]. For since, according to Heister [n. 216], these fibres flow in every direction, therefore they can flow and be interposed and disposed in any direction whatsoever. With these fibres as directors, all is ordered according to the needs of the infant,—a matter which is easy and is of common occurrence throughout nature and especially in the nature of the animal kingdom, which constantly interposes motive fibres wherever any direction of forces is demanded.

309. *Still the force is not a merely attractive force; but it derives its cause from the disposition of the fibres and bloodvessels of the placenta; and the disposition of these fibres is derived from a cause in the whole infant and which comes from its principles of life and motion in the brains. Thus there is a continuous connection of causes, from the first and inmost causes in the fetus to the outmost cause in the placenta where it is applied to the uterus. This connection can also be made intelligible by an anatomical exposition of the embryo's diminutive frame.* The primum mobile of every living body must by all means be derived from the principles of the life of that body, and consequently from the brain and its cortical glands which are the extreme ends of the bloodvessels and the principles[1] of the fibres. All things whatsoever that exist organically in the body, derive their origin from fibres; nay, this is true even of the bloodvessels, and hence also of the motive fibres, which are made up of nervous fibres and bloodvessels. Since then the principles of the fibres enjoy their own life or vital motion and exquisitely perceive whatever the universal body requires, and since they perpetually set up the motion of the parts of their body by alternate animations, it therefore follows that, by virtue of the call given by this principle or beginning, all things that are required flow in by a kind of attractive or syringic force; see Trans. I [n. 349-350]. This sphere [of attraction] extends itself from the first things to the last; that is to say, throughout the whole series of connections, which is continued all the way to the placenta. Here the vessels are so ordered, that the blood flows in according to every need and requirement; for such is the order prevailing in the vessels, that they taper off by nature's usual degrees into the tiniest brush-like extremities, and thus, in a certain ratio, correspond to the principles in the brain.

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[1] It should be noted that throughout the present work, by the word, "principle" is meant beginning or active point of origin; see n. 358.

310. *The sphere of the activity of the embryonic body extends as far as the placenta; and by means of all the intermediates, and lastly by means of the umbilical cord, the brain of the embryo, wherein reside the principles of its vital motions, so corresponds to the body of the placenta, that the latter supplies whatever the embryonic frame requires. This depends entirely on the disposition of the vessels and fibres, and on their continuation.* The disposition of the fibres and vessels will be dealt with in greater detail below, where it will be shown that the vessels must be lessened down and drawn out, in a just series, to their least brushes or capillary threads.

311. *But all this cannot be accomplished without an individual motion of the parts in the placenta; that is to say, without the pulsation of the arteries, both of the placenta and of the embryo. This pulsatile motion is not the same as the pulsatile motion in the mother, but is proper to the embryo itself, arising from its own principles of motion, that is to say, from the animation of its brains and the systole and diastole of its heart, which two motions at this period are synchronous. This is the reason why two arteries from the internal iliacs of the embryo are transmitted through the umbilical cord to the placenta, and, ramifying* *through the placenta and splitting up into capillary extremities, irrigate and modify the whole of the placenta body.* That in the fetus the motions of the cerebrum and heart are coincident, see Trans. I [n. 329]. Into this motion are set the arteries, and indeed the two arteries just mentioned; for without these there would be no pulsatile motion in the placenta, and consequently no active force to be promotive of the blood and correspondent to the motion of the brain and heart. *It also seems likely, that the pulses of the arteries of the embryo, and consequently of the placenta, do not coincide in their moments with the pulse of the maternal and uterine arteries; for the smaller the little body is, the more rapid are the circulations, as is proved by the several subjects of the animal kingdom.* From this cause also it follows, that the placenta is so joined to the uterine vessels, that the uterine blood does not rush into the placenta at any other moments than those in which the embryo itself makes demand. Otherwise the embryo would draw no blood from the mother's supply except when she gave it forth. *This is fully confirmed by experience; for the infant sometimes survives several hours, nay, as much as two if not three days in the womb, after the death of the mother;*[1] *and meanwhile, it feeds on the blood of its placenta and the liquor of its amnion.*

312. *But to resume. There seems to be a certain communion, or some common nexus between the mother and the embryo, brought about by the fibres of the two, both in the placenta and at the same time in the umbilical cord. For there is a certain nervous membrane that invests the uterus at other times than during pregnancy; and a similar membrane is observed to be interposed between the placenta or its outmost tunic and the uterus. This membrane is extended fascicle-wise inwards, all the way to the considerable roots of the umbilical vein, and consequently it reaches still farther forwards around that vein, and perhaps towards the liver of the embryo.*[2] *Meeting this membrane, comes the fibre proper to*

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[1] See App. n. 1.

[2] Outside of pregnancy, the uterus is lined with a mucous membrane, "the nervous membrane" of the text, which invests the uterus "at other times than during pregnancy." In menstruation this membrane undergoes marked changes, becoming extremely porous and thickened in preparation for the reception of the ovum. If the latter be impregnated, it finds lodgment in the folds of the thickened membrane, the extension of which

the embryo, that, namely, which is continued from the iliacs around its two arteries and also along the umbilical cord; and likewise the fibre which is continued from the whole of the arterio-vascular cuticular substance of the embryonic body around the same umbilical cord, all the way to the placenta. Thus, from the umbilicus to the several parts of the placenta, the fibres of the mother and those of the embryo run together; but the manner in which they are united, has not yet been discovered. That a nervous and porous membrane surrounds the cavity of the uterus, see the authors quoted in the chapter on the [Cervix of the] Uterus [n. 216, 228, 232]. That a similar membrane is interposed between the placental chorion and the uterus, see the authors quoted above [n. 295, 296]. That this membrane insinuates itself fascicle-wise all the way to the venous vessels, see above [n. 293,

soon completely surrounds it. This surrounding membrane, called the *decidua reflexa*, is closely united to the external surface of the chorion, is devoid of vessels or glands, and usually disappears about the middle of pregnancy.(*cf.* n. 274, 280; also n. 313–314.) The changed mucous membrane lining the fundus of the uterus where the ovum is attached, becomes the seat of special change and development (*cf.* n. 274 *seq.*), and is called the *decidua placentalis* or *serotina*, in distinction to the *decidua vera*, the name given to the remaining portion of the mucous membrane of the uterus. See Plate VII, fig. 2, where the three membranes are shown as the shaded portions of the diagram. The *decidua placentalis* is that "similiar membrane interposed between the placenta and the uterus," mentioned in the text. The *decidua vera* begins to atrophy after about the fourth or fifth month, and with the growth of the uterine contents, is finally united to the chorion with which it is expelled at parturition,—the uterus in the meantime commencing the growth of a new inner lining. The *decidua placentalis* is destined to form the maternal portion of the placenta. It was clearly discerned by Ruysch, who discriminates it from the chorion (n. 296). It sends deep processes or septa into the placenta (*cf.* 293, 297, 315), referred to in the text as "the membrane extended fascicle-wise inwards." Except at the margin of the placenta these septa do not reach as far as the chorion. They form the external boundaries of the placental blood-spaces, and through them pass the maternal vessels that supply those spaces. Within the spaces thus formed, are found processes of the chorion, within which circulate the brushlike ramifications of the fetal vessels. The latter thus receive nourishment from the maternal blood only through the enveloping processes of the chorion, the blood-streams of the mother and child, being never commingled.

296]. That on the part of the fetus, a certain nervous membrane invests the several arteries and particularly the aorta and its bifurcations, that is, the iliac vessels, and that this membrane is continued by the two arteries, along the umbilical cord, and ramifies everywhere throughout the placenta, consult the authors cited above [n. 291, 293, 295]. Hence therefore it follows, that the fibre of the mother passes over into the body of the embryo; that the fibre proper to the embryo is continued in company with it, all the way from the umbilicus into the body of the placenta; and that on the way, but especially in the placenta, they in some way unite.

313. *Hence we may infer as to the manner in which the affections or signal emotions of the animus in the pregnant mother are able to affect the infant and its little frame so powerfully that actual traces of the emotions are printed upon it, and thenceforth remain. For every affection of the mother's animus induces a general change of state and a particular modification on the animal spirit, and consequently on the fibres of her whole body, and hence also on the uterine fibres which penetrate by this path into the placenta and umbilical cord, and which, throughout this course, communicate with the fibres proper to the embryo. These latter fibres go to the internal iliacs and the aorta, not only by means of the inmost coat of those arteries, but also by means of the several arteries that abundantly irrigate the delicate cutis of the embryo, and all of which in like manner meet in the aorta; for the umbilicus is continuous with the cutis, and consequently with the cuticular vessels of the infant. Thus, from the entire surface of the embryo, the whole of this change of state in the spirits and fibres flows into the internal tunic of the aorta. This inmost tunic of the aorta then continues it through the carotids into the whole cortical substance of the cerebrum, cerebellum, and medulla oblongata and spinalis, in which substance it terminates. And since these substances are the principles of life and motion, and also the principles of all the fibres of the entire embryonic system, it follows that there is a communication of the affections of the mother's animus, or of the state of her brain, with the brain of the embryo, which forms the members of its diminutive frame in agreement with its every representation or implanted idea; and during this period, in agreement with the representation and idea which* *comes over it and is poured upon it by the mother. Yet, by means of the connection between the mother's fibres and the embryo's, it is carefully provided that the embryo shall not be affected by the ideas of the mother unless those ideas be excited to the highest degree.* Respecting the marks which the ideas of the mother imprint upon the embryo, consult the authors.[1] In this place I have desired to indicate merely the mode of the communication; for certain it is that the fibre of the mother is consociated with the fibre of the embryo, see above [n. 312]. That the fibre of the embryo is continued from the brain of the child through all its organic parts, is evident; for of the fibre, is woven every organic thing in the body. That the umbilical cord is continued from the cutis of the embryo, and also by means of the arteries, from its iliac vessels, is also clear. That the inmost membrane of the arteries is their first and veriest nervous membrane, see Trans. I [n. 136, 137]. That this membrane is continued to the whole cortical substance of the cerebrum, cerebellum, and medulla oblongata and spinalis, see Trans I [n. 137, 217, 267], and Trans. II [n. 167, 168, *seq.*]. That this cortical substance is the ultimate organization continuous with these arteries, and that it passes from them into the fibrils, see Trans. I [n. 151–153, 472], and Trans. II [n. 111–131]. That a state similar to that which comes upon these substances is diffused throughout the whole system, see Trans. II [n. 202–203]. From these considerations it unfailingly follows, that the effect of the cause is presented in the exquisitely delicate framework of the embryo which comes forth solely from those principles of its life and motion, and from the representation therein which regards that which is yet to be formed as already formed; see Trans. I [n. 261–262, and also above, n. 175]. *Thus the brain of the mother and that of the embryo communicate with each other and mutually correspond, by means of intermediate fibres. But the influx of the one into the other is effected according to the connection between the fibres of the two in the placenta and umbilical cord; which connection seems to be too loose to allow any but the most powerful of the mother's ideas,—an idea namely, which stirs up the very blood,—to bring its presence into the brain of the child.* That the connection is thus loose, is plain not only from the resultant effect, but also from the first connection in the womb; that is to say, from the mediate or interposed nervous tunic [n. 312]. This tunic is only loosely coherent [with the placenta]; thus it can be only loosely coherent also in the inner parts, that is, in [the inner parts of] the placenta, and in the cord; so that it is not very active, but rather is passive or reactive,—especially since it goes only to the veins. Thus, unless it be excited, stretched, and as it were hardened and inflamed by means of the blood, it would not seem to be able to take any active part. But it does take such part when put on the stretch by inflammation; for every sense, namely, sight, hearing, touch, etc., is put on the stretch by the mere inflammation of its organ.

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[1] See App. n. 9, and also 1 E. A. K., 267.

314. *But this faculty of communication increases by degrees from the first day of conception to its middle period, after which it decreases; and by degrees, it finally so diminishes, that there is almost no communication by way of the fibres.* For while the placenta is increasing in size and the uterine vessels swelling up, and according as the uterus itself becomes as it were inflamed, so this communication also has its increments; for the interposed nervous membrane is then distended and put on the stretch from both sides. This is the reason why some danger threatens women during this middle period of pregnancy. But when the placenta has done increasing and the cord is relaxed, the communication decreases; for the connection becomes looser. *And so, in process of time, the embryo is left more and more to its own disposal and is unbound from its connection with the mother,—first from the inmost connections, and as these are unbound, so also by like degrees are the ultimate connections, until at last the embryo has no longer any need of the sanguineous and spirituous nutrition of the mother. And then, in natural course it prepares and girds itself up for separation and exit.* See above [n. 305]. For every action comes into existence from inmosts, and goes to outmosts, which latter dispose themselves exactly as an effect to its cause and the principles of its cause.

315. *Inasmuch then as the placenta invites to itself the maternal blood and spirit by its own proper force, and at once appropriates it to itself as its own nor gives anything back to the vessels of the* *uterus, it follows that the placenta is also an organ for the purification and secretion of the blood; that is to say, that it repurges what it has drawn out and emulged, and that it takes up no more than a due and suitable supply. and rejects the recrementious parts.* This is a necessary consequence of the points already demonstrated. That the placenta is a purificatory organ is plain from the fluxion of its vessels, that is to say, from its structure. For all its vessels, both venous and arterial, run to the extremest subtleties and to imperceptible threads, and when nature proceeds in this order, everything that is gross and heterogeneous is cast out. Moreover, places of discharge stand open, and also lymphatic ducts; respecting which, see our authors [n. 291, 295]. *For the vessels of the placenta, both arterial and venous, are split up into their last subtleties; and this in such order, that by degrees, they subdivide in so exact a manner, that during the passage to the ultimate threads, there is nothing that is gross and heterogeneous which is not cast off and sent away; and finally, they pour into their corresponding veins nothing but what is purified of all uncleanness.* Respecting the course of the arteries and veins of the placenta, see Ruysch and other anatomists [n. 296], and the plates showing their fine injections.[1] These injections show that the progression is effected by gradual subdivision, that is to say, first, by division into considerable branches, then into lesser twigs, and finally by innumerable twistings, into brush-like extremities which present the appearance of vesicles and as it were glands. The placenta is subdivided into lobes or prominences; for when detached from its connection with the uterus, it falls apart into, as it were, globes, these again into lesser globes, and these into least; almost as is the case in the liver. This is evident from the division that it visibly undergoes when it is no longer a sanguineous structure but abounds with hydatids, as is the case when it has remained in the womb several months after delivery. For it then resembles bunches and clusters of grapes, as may be seen in Ruysch's three figures,[2] where the distinct divisions of which we are speaking, present themselves more clearly to view; for [in degenerating] the placenta breaks up into no other than its natural form along the lines of its former division,—all that has occurred being, that the membranous ligaments and lesser bands that had obliterated its divisions or rendered them as it were continuous, have now disappeared. That by means of the progression of the arteries to their leasts, the blood is purified on the way by like degrees, see above [n. 14, 15], and Trans. I [n. 197, iv, v, vi].

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[1] Ruysch gives a number of figures showing a portion of the human placenta after injection; the injected vessels are so fine and abundant that the whole appears like a mass of the most delicate moss. See his THESAURUS ANAT. II. Tab. VI, fig. 7; V, Tab. I, fig. 1.

[2] See n. 297, note.

316. *Moreover, lest anything unclean, slipping in by chance, should infest the delicate organs of this little body, and that all that enters may be duly purified, the venous blood is delivered by the placenta through the umbilical cord to the liver, which is a second purificatory of the blood.* See the Chapter on the Liver and the mode in which it purifies the blood.[1] This is the reason why in the embryo the liver is almost the first member of the body, and by far the largest as compared with the other viscera. Thus the placenta, relatively to the veins, corresponds to the liver, and relatively to the arteries, to the brain. *That the liver may rightly purify its blood, it sends back its grosser portion from the iliacs through the two umbilical arteries; and this, for the sake of equation in respect to both quantity and quality. For this reason the artery seems to communicate with the vein in the passage through the umbilical cord, and finally in the placenta itself.* This is according to the observations of Cowper and several others, respecting which, see the authors [n. 292, 296]. In this way quantity is restored according to every requirement, and likewise quality, in the placenta itself; for the fact of this same arterial blood returning by the veins, is a consequence of the circumstance that no communication exists with the uterine vessels.

317. *Especially is the blood purified by its extensive circulation through the chorionic tunic which is extraordinarily rich in vessels, and also in the placenta itself, where there are many receptacles and lymphatic ducts. Moreover, to prevent anything pure and spirituous from being lost, lymphatic vessels are added, which absorb the purer essences from the secreted humor and bring them back into the venous blood.* That the chorionic membrane, unlike the amnion, is richly provided with vessels, will be shown below. This expanse is a kind of field or course, through which the vessels can freely expatiate, and thus can constantly bring on a sufficient quantity whatsoever the condition and state of the mother. Respecting the ducts and lymphatic vessels, see the anatomists [n. 291, 295]. The lymphatic vessels everywhere absorb that pure essence which is mingled thoroughly with the spirit; see above on the Thoracic Duct.[1]

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[1] See 1 A. K., n. 200 *seq.*, particularly n. 204–210.

318. *But where there are secretions, there must also be excretions; for were there no excretory passages, the pituitary and excrementitious humor would stagnate, and would everywhere besmear the channels of the purer blood and thus entirely stop the work of formation. The channels of this excretion run through the chorion into the cavity of the uterus, or into its walls, where the largest venous mouths open out and absorb this refuse portion and send it back to the liver in the form of serum.* That there is an excretion through the chorion into the cavity and veins of the uterus, is evident from the chorion itself, which, when compressed between the fingers, exudes a dew of blood [n. 295]; also from the abundance of the arteries there; from the amnion, which strictly prohibits excretion towards the interior parts; and also from the veins of the uterus, which open into the cavity by an abundance of little mouths. It is likewise evident from the fact of the application of the chorion to the concave walls of the uterus as pregnancy advances, so that these walls seem to then take up the excretions immediately; and from the further facts that the veins of the uterus are without valves, and that they communicate with all the veins, even with the internal hemorrhoidal, and by means of these with the mesaraic veins[2] which go to the liver. At any rate, it cannot be doubted that the veins of the uterus do absorb excretions of the kind, that is, that they purify the uterine cavity. Whether the Fallopian tubes also imbibe any portion and send it away into the cavity, is a question. Some anatomists affirm that this also is the case, and they deduce their opinion from the fact that recrementitious matters are found in the abdomen [n. 262; see also n. 282].

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[1] See 1 A. K., n. 162–170.

[2] The mesenteric veins.

CHAPTER XVI

THE CHORION, AMNION, AND LIQUOR AMNII.

319. HEISTER. (*Compend. Anat.*) The membranes enclose the fetus in as it were an egg. The outer membrane, called the chorion, is thick, spongy, villous, replete with a luxuriance of bloodvessels, contiguous to the uterus, and divided into two lamellæ or membranes. The inner or second membrane is called the amnion; it is thin and transparent, is contiguous to the chorion, and has very few bloodvessels or none at all; in it are contained the glutinous and pellucid liquor amnii, and the fetus. These membranes[1] are ruptured in childbirth, and let out their liquor. The *Allantois*, or membrana farciminalis, is finely seen in some animals, especially in cows, is continuous with the pervious urachus,[2] and serves as a receptacle for the urine. It does not exist in man. In the cow it is about twelve feet long, and when inflated with air is more than a foot in diameter so that it is an immense and stupendous part. God has chosen to exempt women from carrying about this load of urine, since in the human fetus the urachus is generally found closed. Some authors would have the allantois destitute of bloodvessels, but Heister has found them in abundance, and has delineated them [in *Ephemerides Nat. Cur.* Cent. VI, Obs. 24]. (n. 241.) In the calf, sheep, etc., the *Urachus* is a pyramidal canal, reaching in the first instance from the fundus of the bladder to the umbilicus through which it passes; afterwards, gradually enlarging, it terminates in the allantoic tunic almost at right angles to the two sides, or transversely in respect to either side. In the human fetus it is not pervious throughout, or at any rate is very seldom so, being for the most part solid like a ligament. Hence here it would hardly seem to serve the use of a canal; especially since no allantois, or other place of like character has been found, into which it might discharge itself. (n. 243.)

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[1] See Plate VII, fig. 2.

[2] The intra-fetal portion of the allantois develops into the fetal bladder; the passage between this and the extra-fetal portion,—the allantois proper—is called the urachus. See Plate VII, fig. 2.

320. Bartholin. (*Anatome.*) The secundine is made up of two membranes: The *Chorion* surrounds the fetus like a circle; it is separated from the placenta with difficulty. Towards the fetus it is smooth, but on the other side, where it is laid over, and agglutinated to the placenta, it is somewhat rough. In the human subject it adheres to the uterus by means of a round fleshy mass, of a reddish color, which is connected with only one part of the uterus. The *Amnion,*—called by some the tunica agmina (lamb-like tunic), charta virginea (virgin's paper), indusium (clothing),—is the thinnest of the two membranes, white, soft, transparent, and furnished with only a few bloodvessels. It is coherent with the chorion, particularly at its borders, and is united to it in the neighborhood of the placenta, and in the middle of the same where the umbilical vessels come forth. A large quantity of humor is found in it. The *Bladder* is for the most part distended in the human fetus, but empty in brute fetuses. A part of the amnion occasionally adheres to the head of the child during birth, and such an infant is then termed galeated (crested) (Cap. xxxvi., p. 301, 303). The allantois does not entirely surround the fetus, but is like a belt or sausage (farcimen). (Cap. xxxvii, p. 308.)

321. Schurig. (*Embryologia.*) Ruysch shows a portion of the third or inmost tunic of the impregnated uterus of a sheep, through which are disseminated myriads of unknown vessels, and in which is prepared the nutriment intended for the fetus. He calls them vermicular vessels, from the circumstance that they creep with wormlike writhings through the whole of the inmost tunic of the uterus. Lister, however, does not agree with this [but holds that the so-called vessels are nothing but glands] (I, i, § 10, p. 13). De Graaf: We have found in the stomach of the embryo, a liquor similar in color, odor, and taste to that found in the amnion. From this he argues that the fetus is nourished through the mouth.

Heister affirms that during the later months the fetus is nourished by the liquor amnii entering in through the mouth. He proved this by the case of a calf fetus which was found frozen in the liquor amnii. In this case he found the frozen liquor stretching as one continuous body through the mouth and œsophagus to the stomach; in the œsophagus it was about the thickness of a finger. **De Graaf**: That the fetus is nourished by the mouth is readily proved by the contents of the fetal stomach and intestines. We have always observed in the œsophagus and stomach of the embryo a liquor similar to that in which the embryo swam. A similar liquor was also found in the duodenum, excepting that on account of the admixture of bile, the liquor there had a slight greenish tinge, and the farther it went down the intestinal tube, the thicker it became. That nutrition is effected also by the umbilical cord, is proved by the case of a whelp which was born without head or mouth, and which perished as soon as the umbilical band was broken. (I, i, § 12, 16.)

322. **Schurig.** (*Ibid.*) **Stockhammer**: Five or six weeks after conception, there appears the delineation of a head, very large compared to the rest of the little body; also of a dorsal spine, curved like a keel (*carina*); and of a neck, no thicker than a thread; the whole of the little machine being scarcely bigger than an ant. In the head or face there appear, instead of eyes, two black points, and instead of a nose, a white line. The brain is like a kind of mucus, and the little skull like a leathery membrane. In the chest and abdomen the viscera are scarcely discernible. The umbilical vessels also consist of short and indistinct fibrils; and from the chorion, or outer membrane of the ovum, comes a sort of fleshy protuberance, adherent to one part or another of the uterus.[1] (I, ii, § 1, p. 30). **Bohn** says that in the first months of gestation the chorion and amnion are at some distance from each other and are kept apart by an interfluent humor, as may be seen in cases of abortion; afterwards they are more closely united, and look like one single tunic. **Drelincourt**, **Bergerus**, and **Blasius** reckon the space between the amnion and chorion as among fictions. **Verheyen** states the contrary; for he would have a humor sweating into the cavity of the amnion through the pores of the chorion (I, ii, § 6, 7, p. 34, 36). The crest found on the head of new born infants, which in males is called the helmet and in females the fillet, is thought to bring good luck. A case where it was used for poison. Midwives are wont to prophesy from it. (§9, 10.)

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[1] It may be observed that Stockhammer is here relating his observations on animal fetuses.

323. *The Liquor Amnii.* Many anatomists, especially the older ones, derive this liquor either from vapors transuding from the body of the fetus, or from sweat, or from urine.—Others derive it from the brain, the nerves, the glands of the eyes, ears, jaws, mouth, and from the serosity of the blood.—Some derive it from the mammæ of the fetus;—others from the little sheaths and porous papillæ of the placenta. **De Graaf** alleges that it varies according to the period of gestation, but he affirms that it proceeds from the chorion into the amnion. **Bidloo** delineates several small ducts which he found with the microscope in the umbilical cord.—**Vieussens** in *Nov. Vas. Corp. System.*, observes that it is elicited by condensation from the nerveo-lymphatic vessels of which the fetal cutis is for the most part made up, and whence it has issued in the form of vapor. [It is elicited, he says, by extremely fine and short excretory tubules which come from the walls of the nerveo-lymphatic duct, and whose extremities end in the cuticle,—just like the extremities of the secretory tubules of the stomach which arise from its lymphatic vessels, and which, woven in with lateral muscular fibres, constitute its villous internal surface. It is therefore clear that the apertures plainly seen in the cuticle when separated from the cutis, somewhat dried, and examined under the microscope, are the little mouths of the above mentioned excretory tubules which occupy the surface of the cutis; the expanded and mutually adherent margins of which mouths have been merged into the cuticle. Since the fetus swims in a lymphatic and nervous juice, it cannot be doubted that the thinner parts of this juice are compressed by involving membranes, especially during the last months of pregnancy, and also by the motions of the fetus, and are thus forced into the excretory vessels already described, and from these into the lymphatic ducts of the skin, from which they came forth, and where] the lymphs, being again admixed, are expended upon the nutrition of the fetus.—**Hoffman** likewise thought that it was strained through the tunics of the fetus, at that time very thin and delicate, as through strainers, and deposited within the circumference of the amnion; but afterwards he changed his opinion, and held that it came from the lacunæ of the uterus, being conveyed through the chorion (I. ii. § 12–15, 18, 19). According to Bartholin the allantois is the middle tunic, lying between the chorion and the amnion (§ 27).

INDUCTION.

324. *The chorion, amnion, and placenta, together with the umbilical cord, that is to say, in one comprehensive term, the secundines, are outmost instruments which belong properly neither to the fetus nor to the mother, but constitute means and communicants between the two, to the end that from the macrocosm a new microcosm may spring up into the world. For without these secundines there would be no such springing into being; that is to say, it would not be possible unless all the things which are to be given up for the nourishment of the offspring were first enclosed in an egg. The chorion and amnion therefore stand in place of the shell of the egg.* The mode in which the springing into being is effected, is altogether different in the case of the vivipara as compared with that of the ovipara; but still in principles the two cases coincide. [In the ovipara] whatever the mother sets before the fetus is put into an egg, and when the albumen and vitellus,—the white and the yolk,—are consumed, the formation of the chick is completed and it breaks the shell. A similar liquor is also extracted by the fetus in viviparous animals,—and this from their blood and fibres. Otherwise the mother would have to sit upon her ova, and in the meantime would perform no use to society as a member thereof, nor to the home as the mother of a family. This would also bring about her death, for she could hardly survive the exclusion of her fetus; and she would be so big, that her preservation would be impossible and she would perish. That the secundines are only instruments, is clear from the fact that they do not pre-exist in the womb, but grow there, and are afterwards separated and thrown aside, new secundines growing up afterwards for the next birth. They exist therefore solely for the sake of the communication between the mother and the fetus, and for the preservation of the latter from all external injuries.

325. *The outmost tunic, namely, the chorion, encloses the placenta in its duplicature, and through this duplicature run its abundant vessels continuous with the placenta,—very much as is the case in the dura mater of the cerebrum.* In the duplicature of the dura mater are contained the great sinuses; between its two layers creep its own proper vessels; and by the side of the sinuses, are the vessels that return the blood from the brain. A similar arrangement obtains also in other parts. This is the reason why the chorion is double. *Thus it is enabled suitably to carry around in a kind of hemisphere, a continuous wave of the placental blood, and, in this way, to so dispense the supply that the placenta shall labor under neither excess nor deficiency.* By virtue of this arrangement, the chorion is a kind of asylum and capacious receptacle for the superfluous blood, in order that the placenta may be continually kept in due condition; that is to say, in order that the enclosed embryo may be held to drawing off no more than its present state requires. For whatever of the blood has once been brought into the placenta is thenceforth the property of the embryo and not of the mother, from whose further power it is now withdrawn.

326. *By virtue of its circulation through so spacious a field, it follows, that the blood can meanwhile be suitably purged; that is to say, can expell its more unclean portion through pores and emissary ducts, into the adjacent uterus or the cavity thereof; so that by this means the placenta projects the grosser part of its blood towards the circumferences, and thus casts it out.* That the chorion is designed for this use may be concluded merely from its external surface, which is uneven, scabrous, villous, and full of arterial extremities of like characteristics; but the contrary is the case on its internal surface, or that which looks towards the amnion, where it is glabrous, smooth, and uniform; and therefore the spring of the liquor amnii does not come from this side. Where there is any outflow of liquor, there we meet with tubulous roughnesses,[1] none of which are visible in this part,—and indeed the amnion renders this impossible. Moreover, the veins of the uterus which are of most ample size, open out by their mouths into the cavity of the uterus; for when air is blown into one of these veins, it escapes into the uterus, and when forced in through one of their mouths, it is diffused throughout all the veins. The same point is also confirmed by the fact of the application of the chorion to the walls of the uterus; and also by the very substance of the chorion itself, which is of a spongy nature. Therefore it is this substance in the placenta, that is to say, the part that surrounds the placenta, that draws the blood from the great body of the mother, while the remaining part rejects the unsuitable portion. By this means also care is taken that no sort of flatulence shall accompany the blood or its humor, and thus insinuate itself into the infantile body; nor shall distend the cavity of the uterus, now that its cervix is thoroughly closed up. For nothing is more hostile to the formation of the embryo than air, against the afflux of which the embryo sedulously guards itself. If this minute world be compared with the great world, and a parallel be drawn between them, it will be apparent that the central, purest, and lightest place, as it were, is in the embryo and its inmost part, that is, its brains; and that the outmost region, whither all heavy things tend, is that last surface which is formed by the chorion.

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[1] Roughnesses caused by the ends of tubes.

327. *The chorion also preserves the delicate embryonic body which it encloses, and which begins and grows from the purest substances and principles, from all possible external injuries,—a function which is also performed by the liquor amnii.* These external injuries come immediately or proximately from the uterus, arising from its serums, recrementitious matters, corruptions, and flatulent elements that exude through its numerous open pores,—all which elements if they came in contact with the naked body of the embryo, might easily break up its exquisitely subtle cuticular tissues, especially during certain of the more immoderate affections of the mother's animus. I say nothing of the most external injuries which are wont to befall the uterus from without, such as compression, concussion, constriction, falls, etc.

328. *As regards the use of the liquor amnii and the path by which the embryo, from its first stem to its last period, receives its nourishment,—these are matters that can never be known except from principles; and therefore for a just exploration of these* *matters, causes must be joined to effects, or effects to causes.* The minds of the learned are drawn asunder as it were, and dissentient, on the subject of the liquor amnii; and this not only as regards the source of that liquor, but also as regards its use, and finally, as regards the path by which the embryo receives its nutritious juice. There are many different opinions; but these I do not desire even to recite, lest I seem by their destruction and refutation to pave the way for my own,—a course of proceeding which I deem unworthy. For the searching out of truer things, experience alone is surely not sufficient; but this experience must be associated with principles; and then, from the connection of the one with the other, we may be allowed to draw conclusions. *First, it is by all means necessary that we know whence and from what elements and principles, the embryo, both during the process of its formation and when formed, receives its growth and nourishment; that is to say, that it receives it from the blood alone, and the spirit of the blood. Then we must know what the blood contains, and what the spirit is; and how from these, fibres and vessels are formed, and from these again every organic thing in the body. Besides this, we must also know what the state of the embryo is when enclosed in the mother's womb, and what this state is as compared with the state after exclusion from the matrix; and also what is the state of its cutis with which the liquor amnii is in immediate contact; and, moreover, several other things, all of which must be known before anything certain can be pronounced with respect to the points mentioned above.* The nature of the blood has been discussed in Trans. I and II; the nature of the spirit will be discussed in Trans. VI, on Psychology.[1] The state of the embryo has also been investigated [Trans. I, n. 324 *seq.*], and must be investigated again; and also the nature of the cuticle or skin,[2] and many other particulars which conduce to the elucidation of the matters in hand.

329. *From a due examination of these several parts, it follows as a consequence, that the embryo derives its nutritious juice and the increments of its corporeal life from no other source than the maternal spirit and blood. The very pathway of the nutrition*

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[1] See the work on the ANIMAL SPIRIT (in Post. Tr.); *cf.* n. 10, note.

[2] See A. K., Part III.

is plainly visible as lying through the placenta and umbilical cord; for this channel is made up of two arteries and one vein, to say nothing of fibres. Also plainly visible is the pathway from the umbilicus to the liver; from the liver towards the vena cava and so into the right side of the heart; thence through the carotids towards the brain; from this again by a kind of circle into the left side of the heart; and then from this into all the viscera and into the whole compass of the embryonic frame. The like is the case in the body after formation, in that the nutritive elements pass first into chyle, from chyle into blood, and then from blood into the whole of the living bodily system. Thus the one only pathway of animal nutrition is by means of the blood and its spirit. Moreover, it will be demonstrated that there is nothing in the whole body that gives it any organic form but the fibre; and that in the vessel also there is nothing but fibre; also that the simplest fibre consists of nothing but the first animal essence or substance, since the simplest fibre is but the determination of that substance; and hence that the fibre which carries the animal spirit is made up of simplest fibres, and the fibre which we call a vessel and which carries the blood, is made up of these again compounded. Thus, excepting the simple fibre, there is nothing formed and nothing organic in the whole of the living body. On the other hand, the primordial saline and sulphureous parts, that is to say, the first elements of the material world, do not enter into the composition of the fibre, but only into the composition of the fluid that runs through the fibres or vessels. Consequently the purest of all the elements of the world, that is, the principles thereof, enter into the animal spirit, while the grosser parts, or those of a lower degree, enter into the blood; and this in order that the latter may contain in its bosom, as in a common treasure-house, whatever is required for the various kinds of humors necessary to life,— not to mention other uses; that thus the organic animal form may be a part of the ultimate world, and perform its functions suitably to the ultimate effects of nature. Otherwise its form would be a part of the superior aura and an inhabitant of heaven but not of earth; inasmuch as its genuine form, that, namely, which is determined solely by the simple fibre and consequently by the spirituous essence, could by no possibility play the part of an inhabitant of the earth. I have chosen to compress these statements into one compendious form, in order that I might exhibit from principles alone, whence and of what principles the animal body is formed and consequently nourished; namely, that the body is formed and nourished principally from the blood, which is the treasure-house of all things in its body; for without the blood there is no bodily life, and hence neither is there any nutrition. These several points have already been dealt with in part, and in part still remain to be dealt with. When they have been demonstrated, it will follow that there is no other pathway of nutrition except through the placenta and umbilical cord.

330. *Since, therefore, the blood is the treasure-house of all things that are to exist in the body; and since the blood contains within it not only the primordial elements whence arise all the families of salts and sulphurs, that is, of terrestrial substances; but also and simultaneously the animal spirit, which, moreover, embraces in more fixed form the purest principles of the world, that is, of nature, and, in addition, that first animal essence which, regarded as a substance, is termed the soul; it follows that the rudiments of the embryo conceived from the spirituous seed of the father and straightway woven into the most perfect organic forms such as are the inmost forms of the cortical glands of the brain, afterwards takes its increments from the spirit* [*and blood*] *of the mother; and this successively, first from her spirit and then from her blood,—wherein is stored up not only the mother's spirit, but also the other prime elemental parts.* Respecting these several points, see our Transactions, especially the last or psychological Transactions. Since they do not immediately concern the liquor amnii, I need do no more than simply adduce them as premises to our conclusion. *But as the embryo grows to its full measure of brain and body; and as the little organs of the brain, rendered active, begin successively more and more to conceive and exclude the first and inmost, that is, the true animal essences; then also in part, the embryo begins to provide for itself and to co-operate with the mother,—receiving from her, accessory and terrestrial parts and a constantly decreasing quantity of spirits. And then, little by little, the embryo is left to itself and its own principles; and thus, little by little, it struggles to escape from the prison-house of the womb.* Such are the points to be premised. Let us now advance to the liquor amnii, its origin and use.

331. *From the above considerations it now follows, that the liquor amnii can never originate from the secretion of the outmost tunic or chorion, nor of the amnion itself; nor can it come from the bladder by way of the urachus. For the chorion is the outmost tunic of all, irrigated by nothing but bloodvessels. Externally it is scabrous and as it were villous; there also it is spongy, while on its inner surface it is smooth and polished. Furthermore, continuous with this tunic and closely united to it, is the amnion, in which no vessels have ever been seen, still less excretory vessels, or tubules leading from the deep parts of the chorion; but the passage from the chorion inwards is closed, and this in order that no grosser and unclean part of the blood may insinuate itself into that interstice, and seriously wound the tender tunic of the embryo, and thus break up the work of formation. Nor does the urinous liquid escape into the amniotic cavity; for in man the urachus is impervious, and even if pervious, it never opens into this cavity, but, in brute animals, into a particular tunic called the allantois or tunica farciminalis, which draws in and stores up the whole of this foul material.* In man the bladder is closed, and sometimes distended with a kind of urinous or rather serous humor. Nor is the urachus pervious, and even if pervious, it never opens into this cavity, but into the chorion; while in brute animals it opens into a particular tunic, the allantois, which is large and capacious enough to hold this humors. The reason of its presence in brutes, seems to be, that brute animals arrive more quickly at maturity, both in the womb and outside the womb, and therefore more quickly attract the unclean blood and serosity of the mother; and when the blood is thus impregnated, the whole of this serous portion cannot be so quickly expelled through the pores of the chorion but that it also passes by way of the bladder and urachus. But it is different with the humor attracted by the embryo, which latter commences its web from more internal origins and proceeds from its first stem with greater slowness, and then for a longer period requires none but the purer essences, and rejects the grosser,—a circumstance that arises from the modes of the coöperation mentioned above.

332. *Therefore, since the human embryo grows up more slowly even from its first stem, and successively milks out the maternal juices according to the requirements of its formation, appropriating to itself those that it milks out, and sending back into the mother's veins by way of the chorion none but the grosser portion; and since the infant over-greedily imbibes those juices, and nevertheless they suit its blood; it follows, that, following the natural circle,—which exists also in the fully formed infant,—it expels towards the circumference of its body, that is, towards the cutis and cuticles, every portion of which it has no need. It does this by means of hosts of little arteries, namely, by those little mouths that open out in such copious abundance on its delicate skin. Thus it reserves for future use, all that portion of which it has no present need; to the end, namely, that it may provide for itself for the coming periods, and may gradually accustom itself to live on its own resources,—gradually, that is to say, in proportion as it puts on the will to assert its own liberty, and to free itself from the mother and the captivity of the womb.* That the serosities of the blood are banished to the cuticles is also a matter of the commonest occurrence in the fetus after birth, and also in the adult. As to the nature of that material which exudes from every least part of the body in the form of sweat and insensible perspiration, see the works of the anatomists; see also above in the Part on the Skin.[1] Since the skin of the embryo is exquisitely delicate, with pores everywhere open and with so great an abundance of vessels that the cuticle is almost entirely red; and since the urachus is not pervious, nor are any but heterogeneous elements sent away through the chorion,—and even here the better essences are being continually brought back by the lymphatic vessels; and since, furthermore, the infant lies in a perpetual bath; what then is more in harmony with the order of nature,—an order which is evident in adults also,—than that, in the case before us, a sweat should exude from the circumference of the embryonic body? That all the matters taken in by the embryo are its own property, see above [n. 303]. I see also that Vieussens and other writers assent to these views [see above, n. 323]. Nor perhaps can it be denied, that there is also some exudation of this humor through the cord,—that is, if Bidloo's statement [n. 323] be correct, namely, that little open mouths are found there; but such exudations would come only from the arterial capillaries which occupy the surface, while the veins have an intermediate situation; in this place, moreover, the chorion is closely conjoined to the amnion. But I leave this point in abeyance.

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[1] *Cf.* n. 14, note; and see 2 A. K. 478–479, 493, 505, 506, 508, 510, n. 470 *seq;* particularly n. 475, 511.

333. *Since therefore so considerable a quantity of liquid is collected between the amnion and the tender little body, it follows by virtue of the order of nature exhibited in adults, that when the embryo requires less of aliment from the mother's store, it feeds on this its own liquor; and thus provides for itself from the store that it has collected, and by degrees begins to take its own counsel for its life.* This is the ordinary state that obtains in adults. For through the cuticles we not only reject sweats and serosities, but we also attract abundance of dews, and this solely according to the changes of the state of our animus and body; see above, in the Part on the Skin.[1] This state is also changed, both in the embryo and in the mother. Were the mother to give to the now maturing fetus its whole supply, the supply of her blood would scarcely suffice; for in proportion to the growth of the fetus itself, so also grow its needs. Thus when it draws from this liquor, it draws from a kind of lake. That the state, both internal and external, is changed, follows from the fact of the vital motion of the fetus, and its self-action in the womb, and also from the distension of the space between the amnion and the body, and from the reaction of the uterus, the peritoneum, and the muscular substance of the mother's abdomen. And so, for gravid and pregnant reasons, the fetus is now constrained to make a change.

334. *In confirmation we have the character of this liquor, in that it is pellucid, not aqueous but glutinous; not unlike the fluid albumen of the egg from which the chick gets its nourishment. The nature of this humor is not only evidenced by chemical examination, but is also indicated by the envelopes wherein it is contained. For the amnion is a delicate tunic, and likewise the cuticle of the fetus; and in these tunics, according to a general rule, no other than a corresponding liquor can be enclosed. This*

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[1] See references n. 334, note 3.

juice is of such a nature that it contains the elements of the blood mixed with aqueous humors. And therefore when the embryo puts forth spirituous essences from its own laboratories, and the other essences are taken in from this liquor, then blood is produced; just as it is afterwards produced from the nurse's milk, which possesses similar parts [*as the liquor amnii*], *that are homogeneous with the blood and proper to it. Thus at last the infant becomes accustomed to take counsel for itself without the aid of the mother, and to prepare its own blood, in order that it may be in a state of separation and exclusion.* The reader will find these particulars explained in another place.[1] A comparison with the egg is especially applicable here; for the chick draws the finer and spirituous essences from the albumen, and lastly from the vitellus or yolk; and when these are consumed, it makes effort to come forth. In respect to the composition of the blood, this requires the true spirituous essence, and, in addition, material elements. Both these are now at hand as the fetus' own property,—the spirituous essence from its own brain, and material elements together with aqueous vehicles from this environing lake. Nor is there anything to prevent the fetus from drawing a part of the same liquor through its mouth and œsophagus.[2] For if the lips be parted, then the mouth is open to the reception of this humor by which it is surrounded; and therefore the humor may pass into the veins by this path also; but the veins found in the stomach,—an organ as yet almost closed,—are fewer in number than the veins of the cuticle. That our purest nourishment is effected by means of the cuticles, and that from here it passes immediately to the brain, see above in the Part on the Skin;[3] to the reception of which nourishment the infant thus accustoms itself in the womb. Something of the same kind occurs here as in many insects, such as bees, etc., which lay up a store for future use. This provisioning, being attributed to instinct, is therefore attributed to, as it were, no cause at all. And yet it openly shows that the soul is an entity of a higher world,—the soul of animals, an entity of higher nature, and the human soul, an entity of heaven itself. And it further shows that it is this soul that commands all these fates, and prescribes the lots; and that it contains in the present, the whole series of formation, and all things, both present and future, that can possibly pertain to the state of its bodily life. But the possession of such a nature by the soul cannot come from herself universally; but there must be some universal ens that perpetually flows in, and to whom belongs the continual gifting of the soul with this faculty. The providence of which we have spoken may indeed be given to the soul as its own property, inasmuch as it receives it from a more universal ens; just as thought is the property of the mind, when yet it receives the faculty of thinking from its soul; and as sight is the property of the eye, when yet the eye receives the faculty of seeing from the internal sensory. The case is the same with these powers as it is with instinct. The representation of all things that pertain to the process of formation, is the property of the soul; but it receives this faculty from the universal, that is, the Divine Spirit. This will be more clearly evident, when we come to treat of the influx of superior entities into inferior. Something of the same kind also occurs in the formation of the infant. The maternal body is its universal world which gives to the embryo the faculty of forming itself, but the formation itself belongs to the embryo and its own soul; for whatever it receives universally, it claims as its own, and completely appropriates. *From these positions it follows that the liquor amnii is genuine chyle, or, that it contains the parts that genuine chyle should contain; that is to say, the veriest essences out of which the blood is to be prepared. Next after it comes the milk which is emulged from the breasts.*

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[1] See above, n. 305.

[2] See App. n, 3.

[3] See 2 A. K. n. 492, 504, 506, 508, 509, 511.

CHAPTER XVII

THE UMBILICAL CORD.

335. HEISTER. (*Compend. Anat.*) The umbilical cord is a structure twisted like a rope; as thick as a finger or thumb; made up of one vein and two arteries called the umbilical vessels; surrounded by a common membrane, thick but soft and as it were spongy by reason of its numerous cells filled with a limpid glutinous liquor; continuous with the amnion. It begins in the placenta by many venous and arterial roots; and ends in the umbilicus or navel of the fetus. It is two, three, and sometimes four spans long. (n. 244.)

336. BARTHOLIN. (*Anatome.*) The umbilical vessels are covered by a kind of common coat or crust, which not only invests all the vessels, but also distinguishes them from each other. The umbilical vein is much larger than the artery and passes through the double membrane of the peritoneum. It is inserted into the liver through a considerable fissure, and [in the other direction] it passes outwards through the umbilicus or navel, sometimes single sometimes double, and divided into two branches. From the navel it goes over the breast, and thence proceeds obliquely to either the right or the left side of the throat and neck. From here it sometimes winds round to the back of the head, then along the middle of the forehead, and so gradually reaches the placenta; sometimes it goes round the neck and then runs at once to the placenta. The umbilical vein exhibits several very conspicuous nodes. The two arteries are inserted into the iliacs, and run to the placenta together with the vein. These arteries do not join the arteries of the uterus, according to the most positive observation of Arantius. I have often pressed the turgid vessels with my finger, and observed that the blood could be easily driven from the vein towards the fetus, but not to the placenta, where the nodules resisted like valves. On the other hand, the blood could readily be pushed from the artery into the placenta. The same thing was manifest with ligatures [for when the umbilical arteries of a living fetus still adherent to the mother, were tied, a pulsation was observed in that part of them which lay between the ligature and the fetus, but none in the part between the ligature and the uterus]. For the sake of this motion the venous and arterial branches are joined by anastomoses within the placenta [in order that there may be a prompt return of the blood running back from the little arteries to the little veins]. Sometimes the little branches of the veins and arteries mount over each other crosswise, both internally and externally; sometimes they are joined to each other by insertion; sometimes they come together at the sides; and sometimes they are twisted together in a spiral manner. The minutest branches of the vessels are put together to form larger branches, united in like manner but by more blunt anastomoses, until the arteries are reduced to four branches and the veins to two, which at last combine into trunks *sui generis,* and emerge from the placenta. The arteries surround the veins, in part accompany them, and in part run alone. Outside the umbilicus and placenta these united vessels as they advance in the cord, are twisted together in a remarkable manner; their circumvolution however, is for the most part so arranged, that from the spiral gyration of the lesser cord a larger cord is produced which presents gyring channels like those in the horn of the unicorn, as can be plainly seen by holding the cord up against the light. We have further to notice in the circumvolution of the cord: [1] That in the vein are seen nodules in spots, rising from the blood appearing through the thin and pellucid tunics. This is not the case in the arteries. [2] At a span from the conjunction, a very remarkable texture is seen, and a rougher and as it were confused contortion. [3. In the external coat of the cord are seen an infinite number of longitudinal incisions like little lines impressed on the surface; on the outside they are tinctured with blood, like those seen in the cerebellum.] The cord is of the thickness of a finger; when dried it becomes thinner. At the birth of the child it should be tied, and then cut off an inch and a half from the ligature. The portion that is left then dries up and separates; but the time of this separation is variable. The umbilicus thus formed and consolidated, is covered with a robust skin or cutis which is capable of immense distention. In some subjects the umbilicus is pervious. [When purgatives, to exert a sedative effect upon hysterical sufferings, to kill worms, etc., are placed upon the umbilicus,] it opens in an insensible manner. After birth, the umbilical vessels degenerate within the abdomen into ligaments,—the vein into the ligaments of the liver, and the arteries into the lateral ligaments of the bladder. (Cap. xxvii. p. 310 *seq.*)

337. **Schurig.** (*Embryologia.*) **Verheyen**: I saw on the sides of the umbilical vein, certain whitish and hardish bodies running out like threads through the whole of the cord. These bodies, he says, look like nerves. (I. iii. § 10, p. 82.) That there are many nodes in the cord is testified to by numerous writers. From these nodes midwives make auguries, but, as a fact, they are nothing more than the twistings and circumvolutions of the umbilical vessels (§ 11). **De Graaf**: It is a stupid midwives' tale that the penis will be larger if the umbilical vessels are not tied close to the umbilicus (§ 13). In a fetus one month old the cord is scarcely longer than a fingerbreadth; but about the time of birth it is about the length of a Paris ell[1] (§ 14). **Riolan**: Sometimes, from the looseness of the cord, the fetus so turns and twists about, that a knot is tied in the middle; this usually results in the atrophy and death of the fetus, due to the cutting off of the channel of nutrition; similar knots, however, are also observed in living fetuses. **Mauriceau** relates two cases of knots in living fetuses; and Schurig himself tells of one. Sometimes the cord is too long, sometimes too short (§ 16, 17). A case is mentioned where the umbilicus was lacking, but its place was supplied by the insertions of the umbilical vessels in the base of a kind of tumor, where a portion of the cord was seen, bound down in the ordinary manner (§ 18). A double cord has been also observed, respecting which see John William Riva, and other writers (§ 19).

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[1] A Paris ell is a little over three feet seven and a half inches. Accumulated experience shows that the cord ranges from five inches to about five feet.

INDUCTION.

338. *The two tunics called the chorion and amnion, appear to be the first born tunics of the ovum itself (which also is surrounded by little tunics), and to be afterwards increased in thickness and capacity according to the increment of the fetus they enclose.* Thus so long as the fetus is within these membranes, it may be said to be concealed in its ovum, in almost the same manner as the chick in its egg (*ovum*). The whole difference arises from the fact that the chick possesses the whole of its food supply enclosed within the egg, while the embryo or vivipara draws this supply from the storehouse by which it is surrounded, that is to say, from the broad expanse of the mother. Hence the chorion is a spongy and soft tunic, whereas the shell of the egg is hard; and the amnion corresponds to the delicate philyra or skin found within the shell. But there is a difference between the albumen of the egg and the liquor amnii of the fetus; for the albumen contains at the same time both the posterior[1] and also the spirituous essences of its chick, while the liquor amnii contains only the posterior essences, those, namely, which are conducive merely to the manufacture of the blood.

339. *The umbilical cord seems moreover, to have existed prior to conception, and in the primitive ovum itself, but to have there been merely a continuation of the inmost tunic; and therefore also, it is still cotinuous nwith that tunic, that is, with the amnion. But before conception, it seems to have been only a minute tubule, devoid as yet of fibres and of its arterial and venous vessels.* For while it lay in its first intestinal bag, namely, the corpus luteum, or was applied over it, it seems to have served as a pore or passage for the juice or albumen contained in the ovum, and to have been continuous with the inmost tunic of that ovum; perhaps also to have served as a sort of exceedingly fine filter for the influent juice which was first secreted in the corpus luteum, and was thus proffered to the ovum. But on these points nothing very certain can be conjectured, except to some little extent, by analogy and by reasoning from things visible.

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[1] The Latin here is *primus* (first), but this seems evidently a slip for *posterior*.

340. *Wherefore all this apparatus, or these secundines, seem primitively to have been the property of the mother, but not of the embryo, since they existed before its conception. Afterwards, moreover, the umbilical vein itself seems to have come from the substances of the mother.* As experience also testifies; for the inmost tunic of the uterus applies itself to the placenta, and passes thence, almost in the manner of twigs or offsets, to the branches of the vein, and finally to the vein itself; see above [n. 312]. Thus the whole extent of the cord, from its union with the placenta all the way to the liver of the infant, seems primitively to have been the mother's; for this path is the universal one; that is to say, by this path is determined the universal influxion which comes from the mother. *But all the other parts of the secundines belong to the embryo; that is to say, the fibres and the arteries, which in process of time so increase and so take on forces that they finally claim to themselves all power of action and wrest it away from the mother. In this way, that becomes the property of the embryo which was first the property of the mother and was afterwards held in common with the mother.* See above [n. 324], and also what follows.

341. *The umbilical cord is inserted in the middle of the embryo and as it were in its middle focus, that is, in the umbilicus or navel, which stands at an equal distance from the highest parts and the lowest, or in the middle between the hypogastric and the epigastric region. And when it has been inserted at this point, it is conveyed in the first instance to a place of the utmost quiet, that is to say, to the bladder, and from there, as from a kind of a center of rest, towards the liver.* That the bladder is a place of the utmost tranquillity, and as it were the center of all the abdominal viscera, which, relatively to it, may be said to be placed in the circumference, see above in the chapter on the Bladder.[1] Hence from the path of the cord through the body of the embryo, we may conclude as to what is the axis of the whole body, and particularly of the lower part of the body; for the cord runs only through the axis. But as regards the relation in which all the other viscera stand to this axis, this is a matter not easily understood unless we first investigate the perfections of superior forms, of which we treat in a special doctrine.[1]

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[1] See 1. A. K., 300 *seq.*, particularly n. 301 and note f, 302.

342. *The outmost tunic of the cord, which is continued from the amnion, the moment it touches the embryo or its umbilicus, is continued to the whole of its cuticle, and afterwards to the peritoneum; consequently it is continuous with all those membranes that surround the fetus, and thus by means of the arterioles, with the cerebrum, cerebellum, and both medullas; that is to say, with all the active principles of the new embryo.* See what was said above on the subject of the skin;[2] to wit, that there is an immediate communication between the cuticle and brain, since by this channel the animal draws in the purest elements of which the animal spirit, so far as regards its corporeal part, is composed. *And if it is continuous with the brains and medullas, it is also continuous with each single fibre. In other words, by reflexion from the brains, it is continuous with the whole organic system, which is a co-ordination built up of nothing but fibres.* For there is nothing in the whole body which does not take its origin from fibres; and in that it is an animal organism and a form, it comprises nothing that it has not received from the fibres and their spirit. See above [n. 309, 329].

343. *Besides this communication with the fibres, which is an oblique communication, there is also one that is more direct. For the fibre brought forth from these its springs, first projects itself in luxuriant abundance into the whole compass of the body; and then by perpetual anastomoses all the way to the placenta, it communicates with the fibres transmitted from the embryo through the umbilical cord together with the arteries.* The luxurious abundance of the nervous fibres sent out into the cuticular circumference of the body, is shown in the plates of Eustachius.[3] In fact, this circumference is everywhere beset with them in infinite numbers; for it is these fibres conglomerated into glands and vessels, that constitute the very substance of the cutis. In the first period of formation, all things pass directly from firsts to outmosts. Relatively to the first, however, the outmosts, apart from the intermediate, are not the last things of the order, but are the next or proximate; for the cutis is exquisitely tender, particularly in the embryo, and therefore it is the next degree. That the membranes are the first parts that are visible, and that within them, in due order, are formed the viscera according to the ratio of the use, is clearly apparent from the anatomy of the infant in the ovum and the chick in the egg. And therefore in addition to the oblique communication spoken of above [n. 342], there is also a direct communication between the umbilicus and the fibres of the cord. Bartholin seems to think that he has observed these fibres, where he says ["In the external coat of the cord I have seen an infinite number of longitudinal incisions like little lines impressed on the surface" (n. 336)].[1] Moreover, where there is an artery there also is fibre, for the first and inmost coat of the artery is fibrous. This part, therefore, is proper to the embryo. *And if we may judge from the adult, it is only the fibre of the embryo's cerebrum, medulla oblongata and medulla spinalis, and not the fibre of its cerebellum, that appears to pass into the cord; and in fact, in view of the communication, almost the whole of this fibre.* For the fibre of the cerebrum and of the two medullas passes especially into the cuticular circumference, and for this reason also it is, that the cutis is so exquisitely sensitive. The cutis also it is that passes into the organs of taste, smell, and in part also of hearing. On the other hand, the fibres of the cerebellum,[1] that is, the fibres of the intercostal nerve and the par vagum, pass especially into the interior viscera, which are destitute of sensation. This is the reason why, agreeably to Malpighi's experience, the cerebellum[1] comes into existence later, that is to say, after the cerebrum.[2]

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[1] See the FIBRE, n. 255 *seq.*, "On the Degrees of Form."

[2] *Cf.* 2 A. K., n. 504, 508, *seq.*

[3] The reference seems to be to Eustachius' ANATOMIA, Plates XXI and XXIII, which exhibit respectively an anterior and a posterior view of the human body, showing the immense abundance of the cutaneous nerves.

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[1] In the original, Bartholin's words are represented merely by two dashes, indicating that the quotation was to be inserted later. The citations from Bartholin prefixed by our author to the present chapter, do not seem, however, to contain anything applicable to the text; and the same remark holds good of the whole of Bartholin's chapter on the cord, with the exception of the passage which we have added to our author's anatomical citations. It is possible that the word, "Bartholin" in the text is a slip for "Verheyen," whom our author quotes at the beginning of the chapter, as saying that he had "seen on the sides of the umbilical cord certain whitish and hardish bodies running out like threads through the whole of the cord,"—which threads, he says, look like nerves (n. 337).

344. *The cord is also continued from the arteries of the whole embryonic body, and consequently, by this path, also from its fibres and its sanguineous system.* For the two umbilical arteries come off from the iliacs, that is, from the first bifurcations of the aorta, and this in order that the communication may be rendered surer and larger. By the pathway of these arteries the cord also communicates with the cerebrum, for the last branches of the arteries end in the cortical substances of the cerebrum. See Trans. I [n. 234], and II [n. 111–116].

345. *Therefore there is nothing in the embryonic body, from its first things to its last, that does not communicate with the umbilical cord, and by this means with the placenta. Thus the communion so extends to the single parts, that in the whole embryo there can be no change of state, but is at once communicated to the placenta. For whatever arrives at the beginnings of the fibres, arrives at so many minute and inmost sensories; consequently every change of state in the embryonic body is brought to the placenta as though actually present there, and the placenta is bound at once to put on a corresponding state. Yet there is no sensation such as is experienced in the waking state after birth, but a sensation like that of the cerebellum relatively to the viscera to which*

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[1] The Latin here is *cerebrum*—a slip for *cerebellum;* see n. 360, and PERIOSTEUM, n. 4.

[2] See Malpighi's latest observations on the formation of the chick, which he published in a letter to the Royal Society, dated Oct. 1672, and entitled *De Ovo Incubato.* At the end of the first day Malpighi observed three vesicles which were the primitive brain. At the end of thirty hours he noticed two additional vesicles, and at the end of forty-eight hours he intimates that these latter vesicles constitute the cerebellum. His words are: "After two days the chick was furnished with vesicles representing the cerebrum; to these was added the cerebellum together with the spinal marrow." See 1 E. A. K., n. 243, where our author quotes portions of Malpighi's observations. See also n. 242 of the same volume where citations are made from Malpighi's first and more detailed observations, undertaken earlier in the same year (1672) and published under the title *De Formatione Pulli in Ovo.*

its fibres go; that is to say, a sensation which does not reach any distinct idea of the mind, and which therefore is called natural instinct. For while the cerebrum lies still closed up,—its interstices unopened, and at the same time the lungs not breathing,—all things are as it were in the deepest sleep and live under the auspices of nature; and nature acts from inmost things towards outer, but not from outmost to inner, or from the external senses to the internal, as in the waking state. This latter state is perverted order, unless it be constantly kept as it were passive under the auspices of the internal senses. When we act upon interiors actively, our life is indeed rational, but it is much more imperfect than the natural life; for as a rule, the natural progression and order is then greatly perverted.

346. *Lastly, the cord is continued to all the abdominal viscera by means of the peritoneum.* For it follows the peritoneum all the way to the bladder, and in this way clothes the bladder. As to the manner in which the peritoneum communicates with the viscera enclosed within it, see above.[1]

347. *But the communication of the embryo with the mother is a somewhat oblique communication, namely, by the umbilical vein with the liver, and then, by a certain venous duct, with the vena cava and the heart; so that a large part of the liver itself seems to be attributable to the maternal fibre. Yet there is no direct communication between the mother and the active principles of the embryo, that is, its cortical substance, but only an oblique communication and one that is effected by contact.* This follows not only from the connection of the parts, but also from the effect of the mother's imagination, which, unless it be excited to the highest pitch, has no sensible communication with the embryo [n. 313, 327].

348. *But this communication gradually decreases even to obliteration, and little by little, the embryo is left to itself, its own nature, and its own principles of life and motion.* On these subjects see what has been said above [n. 329, 334]. *And finally it is completely obliterated; and then all the force comes from the embryo itself as its own proper possession,—a force of such nature, that it can be separated, and the infant left to*

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[1] *Cf.* 1 A. K., n. 320 *seq.*

itself. This may indeed happen a few months before the time of parturition, as is evident in the case of fetuses born at six, seven and eight months,[1] which nevertheless live and grow up. But in regard to the degrees of natural diminution and separation conclusion can be made only from the effect, and, to some little extent, from causes also,—as when the fibre of the cerebellum passes over into the liver, and the umbilical artery begins to dominate over the vein, and itself dispose the several parts so that they shall be rightly ministered to by the placenta. *After the birth, however, all particular communication between the body and the umbilical cord is lost,—though a universal communication still remains; and therefore the cord solidifies and degenerates into ligaments.* The part of the cord that is cut off [and remains attached to the umbilicus] dies of itself, and falls off a few days after birth; and then also perishes the arterial communication and thus the nervous; for the infant then looks only to itself and its cuticular periphery with the viscera enclosed therein, and not to any extraneous placenta, nor, by means of the placenta, to the mother.

349. *Since therefore the fibres of the whole embryonic body, and also its bloodvessels, regard the umbilical cord as a middle axis; and since through this cord they aim at the placenta as their ultimate term, it follows that the embryo according to its every change of state, by means of the umbilical cord so disposes the placenta, that the latter supplies itself with that precise quantity and kind of fluid which the state of the body demands. For the placenta is nothing but an expansion of the umbilical vessels, and such is the communication between the two that the one is absolutely communicated to the other.* That the placenta is an expansion of the vessels of the umbilical cord, is evident from its anatomical description; for the arteries therein, as well as the veins, expand separately and split into the finest threads. The arteries also unite with the veins in divers ways, namely, according to Thomas Bartholin, by application, by anastomosis, by mounting over each other, and by insertion both oblique and direct [n. 336]. *In this way it is disposed in accordance with every state and change of state in the embryo; which*

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[1] The text here says, "Seven, eight and nine,"—which appears to be a slip.

state is communicated to the placenta by means of the fibres and arteries. Thus from this store in the placenta, blood or nutritious juice is communicated to the embryo according to its every need; and from the universal store in the mother, it is supplied to the placenta in successive order. All these are consequences following from the connection of the parts. For since every change of state is communicated to the placenta (see above [n. 349]), and since the placenta draws the whole supply from the mother when it feels the general need, it follows that the connection is of such a nature, that the embryo commands the placenta and by this means the mother. Thus every want is supplied. But to deal with all these points in full detail would require many pages; for we should have to explore the connection of the several parts in the embryo, cord, placenta, and uterus. The existence of a connection and communication of the kind in the cord and placenta is evident enough, for in both, the artery communicates with the veins, though in different ways. Whatever comes in contact with the embryonic body, brings to the principles of the infant a highly exquisite and inmost sensation; and according to the knowledge thus brought in, the soul of the infant makes suitable disposition,—yea, and clearly takes note to the end that it may make such disposition. If these particulars are duly considered, we shall be able to some extent, to search out the rationale of the influxes and harmonies, and the mode in which they are co-established, both between universals and their singulars, and mutually between universals themselves. But this matter is too deep to allow of being delivered thus slightly; for we do not learn from bare exposition, but from confirmation arising out of facts and the collation of many experimental observations; and in the present state of our ignorance this would require pages, nay, and also doctrines.

350. *The cord is as it were the rudder and helm, and the embryo the mariner that governs it and thereby so directs the vessel of the placenta as to bring it into a state corresponding to its own, and this, by a government that is inmost, mediate, and outmost.* For all communication of the embryo with the secundines, and by these means with the uterus, is effected by means of the umbilical cord which occupies the place of the helm; for its expansion is the placenta, yea, and also the tunics, that is, the chorion and amnion.[1] All these are to be regarded as continuous peripheries, or as surfaces, and the cord as the axis. *The inmost communication and correspondence between the embryo, the placenta, and the uterus, is instituted by means of the fibres, which are prior and anterior to the vein and arteries and through which is transmitted the genuine spirit or the prior essence of the blood.* The fibres have been treated of above [n. 302, 339], where it was shown that fibres enter into and make up the primitive cord, and that the spirit builds up the purest organs. *The mediate communication or correspondence is instituted by means of the blood both venous and arterial.* The blood comes next in the order of succession; for the arterial vessel is made up of nervous fibres, and the blood itself principally of spirit, see Trans. I [n. 91–96, 472]. Hence this communication is the next in order; for an entire series is required before the communication is perfected. *The outmost or last communication or correspondence is effected by means of the external governance of the umbilical cord. For this cord is determined in such a manner that the embryo is enabled to direct the placenta according to every general change of state, causing it to supply the precise quantity that the common state requires. The embryo seems to manage this helm in a general manner, not with its hands but with its neck.* For the umbilical cord follows the middle of the breast and applies itself to the neck, running at last towards the forehead or head and so to the placenta; sometimes also it curves round the neck [n. 336]. The embryo also makes various movements, and as it were changes its places,—and this, as it seems, solely for the purpose of guiding this helm in a general manner, namely, by pulling on the placenta or letting it go, according as it is required to supply more or less of blood, or to draw more or less from the womb. This appears to be the reason of the many variations and sensible motions observed in the embryo; also of the twisting of the cord, and of the nodes found therein; sometimes also, it passes round the fetal neck, almost as though it wished to strangle the infant in its coil. By these means the controlling of the state of tension is carried farther forward and done in greater detail, in order that the embryo may govern the cord according to its own state. *It is this government, therefore, that seems to be the cause of the many and various motions made by the embryo in the womb during the last months of gestation; and the cause also of the nodes often seen in the cord, and moreover of the twisting of the cord round the neck, and of the variety in its determinations during its course from the placenta to the umbilicus.* This follows as a consequence from what was said just above.

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[1] The Latin is *Nam expansio est placentæ, imo etiam expansio tunicarum, seu chorii et amnii.* (For it is an expansion of the placenta, yea, and also of the tunics, that is, of the chorion and amnion.) This is contrary to our author's statement in n. 349, 351. We therefore suggest the reading on which the translation is based, namely, *Nam expansio est placenta, imo etiam* . . . *tunicæ*, etc. Perhaps, however, *extensio* should be read for *expansio*. In that case the passage would read, "For it is an extension of the placenta, yea, and also of the tunics, that is, of the chorion and amnion."

351. *But these several operations could not be carried on without an active force, nor consequently without motion. The active force belongs to the embryo,—namely, the first force, acting through the fibres, the second, through the arteries and their pulsations, and the third, through the leadingstrings of the cord itself. But the several principles of the activity are the property of the embryo itself and not of the pregnant mother.* There is no room for doubting this, so far as regards the fibres and the passage of the spirit through them; for there is nothing that is truly animal or animate except the fibre. So likewise as regards the pulse of the arteries, which is communicated to the whole placenta into which the arteries expand; for the placenta is an expansion of the arteries and vein of the cord. *It is therefore the system of the embryonic body that requires more or less of juice, and juice of a precise quality,—namely, that thirsts and hungers for it, and demands and invites it.* Thus all is in a kind of equilibrium, and hence the dispensation of the several supplies arises solely from the need of the particular and universal state.

352. *That all these operations may be carried on by a kind of spontaneous effort and in an order most highly suitable to nature, the purest essences of the blood, nay, and the blood itself,—we mean, the purer blood,—do not run through the body in straight lines* *but by a kind of perpetual circulation. For the veriest form of the purer parts is the perpetuo-circular or spiral, and wherever a fluid has the freedom of determining its path according to the form of its own fluxion, that path will be according to the form inherent in the parts of the fluid,—parts, a volume of which determines itself through a course of fluxion by virtue of established laws of nature. This is a fact which we meet with everywhere throughout the entire organic body. Thus all resistance is taken away and the blood then flows of its own nature.* That the umbilical cord is twisted into perpetual spires, and this naturally, is evident as an anatomical fact. That such a gyre was instituted from the very beginning, is plain from the first intestinal body, the corpus luteum, which is twisted into gyres of the kind; likewise from the several parts of the body, which as it were love this kind of circumgyration; nay, and also from the little arteries, which, as shown by the microscope, are curved into similar perpetual gyres, so that in the space of a single drop Leeuwenhoek observed more than a thousand little twirls. In this axis, that is, in the umbilical cord, the blood and its spirit have had freedom to institute a fluxion in accordance with their whole nature. Hence it comes to pass that the cord comes into the form of a perpetual screw or spiral, in accordance with the nature of the fluxion of its parts; of which matter we shall speak presently. That the most perfect entities of nature strive to the supreme determinations of forms which I term celestial forms, and the next succeeding into vortical forms, the next again into spiral, then into circular, and lastly, into rectilinear and angular, will be made clear in our Doctrine of Order.[1] The simplest fibre is self-determined into the celestial form, the compound fibre into the vortical form, and the vessels that carry the purer blood, into the circular form. It is only the serosity with which the blood abounds, that naturally tends to a straight line; and therefore the blood flows into this form,—a form unwelcome to the blood and forced upon it,—just in proportion to the quantity of its accompanying serum. As soon therefore as the blood is freed from its serosity it flows into the spiral or perpetuo-circular form. Such is the case here with the blood running through the umbilical cord; which is a sign that it was the purest blood of the fetus that ran through the cord and laid down the way. Thus the cord offers the minimum of resistance, and a determination that is natural to it; nor is there any repercussion, such as would be present if the cord ran in a straight line while the blood was striving to the circular form. Respecting the circular volution of the parts of the blood, see Leeuwenhoek,[1] and also Trans. I [n. 65, 203–204, 556].

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[1] See n. 131 note; it is possible however, that the word "order" is here a mistake for "form;" for it is the Doctrine of Form to which reference appears to be made. See that doctrine set forth in the FIBRE, n. 255 *seq.*

353. *From the particulars that have been discovered by anatomical experience respecting the umbilical cord, it further appears that at the earliest period, the cord, as well as the skin of the embryo, exudes that liquor called the liquor amnii, which is the genuine chyle of the body; and that in the subsequent period, the cord together with the skin, absorbs the same and gives nourishment therefrom to its blood.* For the umbilical cord is environed with a tunic which is continued not only from the amnion, but also from the cuticle of the embryo. Thus by means of this envelope, the body of the embryo, that is to say, its surface, communicates with the tunic of the amnion. The cord moreover, is quite thick and spongy, so that in like manner as the skin of the embryo it can exude and can likewise absorb a liquor of the kind. It appears to be spongy on the inside, where also are found vesicular substances distended with a similar juice. Moreover, it floats in the liquor amnii. On injection and compression, pores and ducts come to view, or lesser lacunæ, through which the communication is brought about. From the above, the conclusion is sufficiently obvious that the state of the cord is almost similar to that of the cuticle, or rather that it is intermediate between that of the cutis and that of the amnion. If it exudes anything, or absorbs anything, there is an immediate communication with the embryo's cuticular circumference, and also with its peritoneum wherein a similar chyle, nay, liquor, abounds from the very earliest period.

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[1] See 1 E. A. K., 29.

CHAPTER XVIII

GENERAL REMARKS ON THE STATE OF THE EMBRYO AND ITS INITIAL STAGES.

354. *From remote antiquity to the present day there has been controversy among the learned as to what the father contributes to the life of the offspring, and what the mother; and whether the soul is infused into the rudiment from the first moment of conception, or whether it is put in afterwards,*[1]*—that is to say, whether it comes by engrafting, or by inspiration. But because we are fond of reasoning and decreeing on the subject of the soul and the life of the body before we have duly considered and discussed the objects immediately around us and those that lie in our path and intervene between us and the soul, therefore we dissert on these themes as on objects lying in the most profound and darkest abyss whither our eyes cannot penetrate. Hence arise confirmations, doubts, dissensions, and hypotheses, to which our judging faculties, acquired and exalted by experience, doctrines and the gift of reasoning, lend their favor; or, in the absence of these, a quasi enlightenment from an inward light,—which, however, is more truly an adumbration from externals; moreover also, the voice of authority, and hence a faith not intellectual; not to mention other consequences.*

355. *But before it is possible to make any rational assertion respecting the propagation of the soul, whether by engrafting or by infusion, it first and by all means behoves us to know what the soul is, what the animal spirit, and what the blood, nay, what the body; for the spirits are subordinated to the soul, the blood to the spirits (which are called the animal spirits), and the body to its blood. And when we have learned, in general and thus indistinctly, what the soul is, we ought then to know what its determinations are; also what those of the animal spirits are, and lastly what those of the blood. The former are called fibres, and the latter vessels. Then at last we come to inquire how the soul insti-*

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[1] *Cf.* App., 1-2.

tutes its intercourse with the body; what is the nature of the harmony between them, and what the nature of the disharmony; also, what is their influxion, regarded both from the body's side as physical and from the soul's side as metaphysical. Influxion does indeed involve something material, when yet, whatever is material, is inapplicable to the soul which is immaterial and a spirit. But nevertheless influxion must be predicated by way of analogy; for it is an evident fact that there is here a communication and harmony. But we shall fully explain these matters in our Introduction.[1]

356. *Therefore until all these points have been explained, we shall never have done enough to enable us to decide as to the source whence comes the soul of the offspring,—whether it is a graft from the male begetter, or whether it comes also from the female bearer; or whether it be divinely infused. When we have so far sublimated our intellect that we know what the soul is, then, in order to solve these questions, it will be indispensably requisite that we explore the nature of the contents carried by the genital members of both sexes,—the contents, namely, of the testicles, epididymides, and vesiculæ seminales; and from these and other testimonies, the nature of the seed; and also what the correspondences in women are. We must advance in order, from things last to things first, or from effects to principles; and when at last by following this path we have arrived at principles, we must descend from these, and thus from what is prior and higher, to effects,—even like the soul itself and the spirit, which descends from causes to effects, from the first nature to the last, and from the very first elements of the sciences to their rudiments.* This is the reason why I have felt it necessary to first run through the field of effects and the anatomy of the body.

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[1] Probably the INTRODUCTION TO RATIONAL PSYCHOLOGY, which was to form Trans. V of the Economy, see n. 10 and n. 20 notes. The subjects of Trans. V, were to have been treated of in "Part" XII, of the Animal Kingdom series, which Part also adds the subject of Influx. See the prospectus prefixed to the Animal Kingdom, Vol. 1. The little work on the ORIGIN AND PROPAGATION OF THE SOUL (in Post. Tr.), and also an earlier treatise on the MECHANISM OF THE SOUL AND BODY (3 Phot. MSS. V.), were probably written as drafts of this Trans. V, or Part XII. See also the INFINITE Pt. 2. "On the Mechanism of the Intercourse between the Soul and Body."

357. *We may not however climb immediately from effects to principles, from the body to the soul, and from the material world to the immaterial. And therefore, in order to this ascent, I have been obliged to as it were conceive from an ovum, form, and bring forth new doctrines, which shall lead me from lowest things to higher; doctrines which I term the doctrine of form, the doctrine of order and degrees and also of the society of co-ordinates, also the doctrine of representations and correspondences, and lastly the doctrine of modification. All these doctrines must first be laid down and explained, before I dare to mount or attempt that ladder which leads from earth to heaven.* *These several doctrines will be delivered in our INTRODUCTION TO RATIONAL PSYCHOLOGY, which constitutes Trans. V.*[1] But O, how lowly placed are we inhabitants of earth, and far removed from such sublime subjects! And yet we aspire to climb at once to the very heights, though in our path lie infinite things which must first be explained and revealed before we can reach even the threshold of this temple.

358. *When we shall have gone through all this, it will at last appear that somewhat of the father's soul produces the initiaments of the embryo and the principles of all that will exist in the new body. Also, that these principles, which reside in the soul alone and are now its property, successively call forth and beget, by a mode of supereminent generation, their likes and fellows,—all which may thus be said to be conceived and procreated by engrafting from the soul of the parent. And that with the exception of these principles which govern and promote that universe, all the rest are the mother's; thus that the principiates exist from the soul of the embryo and the soul of the mother conjointly.* The principles are all those things that exist in inmosts, and, in the present case, in the inmosts of the cortical substances which are inmost sensories and motories. Nature commences her web from inmosts and then proceeds outwards; but this would not be the case were the soul to be infused after the formation of parts posterior to it.

359. *As regards the formation of the embryonic body from the ovum until birth, the following are consequences flowing from the*

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[1] In the Latin the words between the asterisks are in italics.

laws of nature: That the formation of the body progresses in order and by degrees, from firsts and inmosts to lasts and outmosts, and therefore from the soul to the viscera of the body. Hence that all things come into being successively, and that in least things there is no real type of the greatest, save a representative one; in order, namely, that the soul may represent to itself that which is yet to be formed as already formed; whence, according to the order of these representations, all things follow in succession. Comparatively speaking, the case is not unlike as when the mind embraces simultaneously in one view many actions and effects from the first cause through the middle causes to the last causes, that is to say, a whole series; which actions and effects, however, succeed each other in their own order, and in that order the ends remain everywhere the same, that is to say, the first, middle, and ultimate ends,—nature advancing only through effects, to which belong moments and degrees. And when the soul advances thus, that is to say, from the very principles from which all natural things proceed, nothing can hinder the just effect from following.

360. *Thus from the spirituous seed are first produced the inmost and eminent little organs or sensories of the cerebrum; then from these is produced the fibre or first stem of the medulla oblongata and medulla spinalis; afterwards the cerebellum is initiated into partnership in the operations;*[1] *and these, taken together and environed with a web of the most delicate kind, constitute the carina. Therefore, after this highest region of the body has been first formed, the others that are under it, and are external and inferior, are formed in their own order, taking their origin from the brains as from their Olympian heights. For there is nothing existent beneath the cerebrum that was not primitively shapen by the fibre of the cerebrum,—it being the fibre, and hence the cerebrum, using the word in a broad sense,*[2] *that rules universally. Then first comes the little heart, which performs in the corporeal kingdom the vicarious function of the brain and its soul; and this in*

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[1] See n. 343.

[2] The Latin word *cerebrum* means both the cerebrum in particular and also the whole brain. When the latter meaning is intended, our author uses sometimes, though rarely, the term, *encephalon;* sometimes the phrase, *cerebrum late sumptum* (the cerebrum taken in a broad sense); and sometimes, simply *cerebrum.*

order that the heart may rule the blood, while the cerebrum, using the word in a broad sense, rules the animal spirit, and the soul rules both. Thus, under the auspices of the soul, all discord is at last turned into concord. Hence comes the mutual love between all the parts; for everything whatever that is in the body is its own, because it is the soul's,—which is present indeed all over, not however in one way only, but everywhere in a different way. But as to the order in which all the parts mutually succeed each other, this must be learned solely from the anatomy of the chick in the egg,—though any comparison of ovipara with vivipara should be instituted with caution.

361. *In order that the work of formation may be carried on rightly and according to the order of nature, the embryo, immediately on the emigration of the primitive ovum from the ovary, is left to itself and its own nature. For nature acts from inmosts and from her own principles, that is, from supreme principles and from the soul itself in which these principles naturally lie; that is to say, she acts in the most perfect manner. Wherefore the embryo is completely exempted from the right and will of the mother who carries it, and who concurs in the work only as a superior universal inflowing into an inferior universal; that is to say, by supplying all that store which the embryo requires and demands. For were the mother to concur in any other way, the formation would soon go to wreck, since the mother is carried away not only by the principles of nature, but also by the principles of the will. For the principles of the will rule constantly during the day; and these principles are formed by things ultimate or postreme, that is, by objects of the senses which are fallacies and which distract the animus and even the mind, and hence pervert the blood and spirit and alter their circulations every moment, whereby the delicate fabric of the embryo would soon be torn to pieces.* The animus of the mother does indeed flow into the principles of the embryo, but before this can take place, the forces must be carried up to the highest pitch, such being the nature of the conjunction between the mother's fibres and the fibres proper to the embryo; on which subject see above [n. 313, 347].

362. *In order then that whatsoever be the character and circle of the maternal blood, the embryo may nevertheless not be destitute* *of its own supply of quantity and quality, it has formed for itself a placenta, and has conjoined it with the uterus only slightly and on the surface; which placenta is a receptacle and larder from which it draws its essences, that is, blood, serum and spirit; and finally it provides for itself an abundance of chyle, that is, of liquor amnii, in order that it may draw whatever it has need of, from its own store and not from the mother's.* But on these subjects see above [n. 300 *seq.*, 332–334]. For whatever the fetus derives from the mother into the placenta, in a word, into the secundines, becomes its own property as soon as ever it passes over the threshold of the placenta.

363. *The embryo does not always imbibe from the maternal store, defecated juices, but sometimes juices that are more or less impure, when yet it requires blood and spirit of exquisite quality. Hence it has formed for itself purificatories, that is divers filters and strainers. For the first essences, already cleansed according to due need, are drawn from the placenta, where the embryo has divided all the vessels both venous and arterial to extreme subtlety, and reduced them to order. Afterwards it carries this blood, not yet sufficiently purged, to the liver, where it again purges and examines it. From the liver it sends the blood first into the vena cava, and then by a remarkable valve*[1] *into the* [*right*] *auricle of the heart and through the foramen ovale* [*into the left auricle; thence*] *into the left ventricle, and thence to the brains; these derive its purest essences, extracted in their cortical gland, into the fibres. The remaining portions which are in great part deprived of their spirit are sent into the sinuses of the dura mater, and from there, through the jugular veins, into the superior vena cava, and from this into the right auricle and ventricle of the heart, thence through the trunk of the pulmonary artery and through the ductus ateriosus, into the descending aorta. From the descending aorta, on the way towards the iliacs, the blood is derived into the thymus gland where it is again purified and secreted. Lastly the remaining and viler portion of the arterial blood is forwarded by the iliac arteries through the umbilical cord into the placenta, where, being again commingled with venous blood, it institutes a circu-*

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[1] The Eustachian valve, a membranous semi-lunar fold in the right auricle of the heart, guarding the margin of the inferior vena cava, and directing the blood to the foramen ovale. See 1 E. A. K., 339.

lation and by means of the tunic of the chorion, rejects its heterogeneous and foul parts in order that it may return to the embryo as a homogeneous fluid, and so again take up the course. The circle thus described by the blood is as it were a double circle, but reflected; and yet it is continuous and emulates a kind of spiral.[1] *There is moreover, a still simpler and prior circle of the blood, namely, when the little heart is not yet united and conical but consists only of three vesicles.*[2] *Again there is a more compounded circle; that is to say, after birth when the foramen ovale and ductus arteriosus are closed, and the lungs open. Respecting these several circulations, which are three in number and follow one after the other, see Trans.* I [Chap. IV. n. 316 *seq.*] *"On the Circulation of the Blood in the Fetus, and on the Foramen Ovale."*

364. *The recrementitious parts which are necessarily contained in the serum of the blood and in the blood itself, are rejected principally by three ways:* [1] *The grosser parts are rejected through the chorion into the cavity of the maternal uterus, or into the veins opening therein, and from the cavity they are afterwards sent off by different passages.* [2] *In the embryo itself they are rejected to the bladder, which at birth is found somewhat distended with urine; for the passage through the urachus is impervious, since in man there is no tunica farciminalis to receive the urinous fluid and separate it from the liquor amnii.* [3] *Finally, there is a rejection into the intestines, which are found infarcted with meconium.* *This meconium seems to come down chiefly from the liver and gall bladder; for the first bile separated from such innocuous blood cannot possibly be acrid as in adults, since at this period there is nothing to excite rage or anger, or to perturb the blood, unless perhaps it be some emotion kindled in the animus of the gestating mother.*[3] *Moreover, it seems very probable that a certain amount of nutriment or chyle is taken in by the mouth of the infant from the liquor amnii* [n. 234],—*and this, in order that the stomach and intestines may become accustomed, the one to the chyle and the other to some kind of meconium, and thus may be duly inaugurated into their uses.* *That this meconium is formed from the chyle mixed with innocuous bile, is indicated by anatomical experience. But only a mere drop of this liquor amnii seems to be thus taken in, since the œsophagus is but slightly opened; were it wide open, then, in less than an hour, the whole of the liquor amnii would rush in, there being nothing to hinder it.

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[1] See further concerning this double circle, 1 E. A. K., 330 *seq.*, particularly 333.

[2] See 1 E. A. K., n. 290 *seq.*

[3] In the Latin the words between the asterisks are printed in italics.

365. *But as regards the mother, she is variously affected according to the various calls of the embryo. For during the first days the embryo desires none but the mother's purest essences; then grosser essences, and at last pure blood and its corresponding serum. Nay, as soon as ever she conceives in her ovum the rudiments of the embryo, her soul, well versed in the state, and admirably conscious of its existence, brings forward, at the least signal, all the things which can ever be required. For as soon as conception takes place, the cerebellum sends all its spirits into the fibres that go to the ovaries, Fallopian tubes, and uterus; and leaves or sparingly provides for the rest of the fibres which enter into the face, the organs of the senses, the stomach, intestines, mesentery and the rest of the viscera. It also prodigally bestows the spirit upon the blood and its arteries, that the blood also may supply this spirit; and afterwards it goes immediately to the blood itself, and to its serum and watery portion. Hence follow the several changes of state experienced by gravid women, all of which are effects arising from the appetency and suction of the embryo.* *These changes I wish simply to enumerate.[1] They are: Pallor; a certain weakness of the inmost sensation and also of the middle sensation, and of the internal senses themselves; the eye grows conspicuously dull, and with the extinction of the woman's fire and beauty, it becomes somewhat darkened; a cloud hangs upon the lower eyelids; hence comes languor in the actions, that is, a loss of that vigor which before had been excited by enkindled venery at every glance. Sometimes, also, there are swoons; for when the spirit is deficient in the remaining fibres of the cerebellum, and also at last in those of the cerebrum, then not only the intellectual sphere, but also the motor sphere of the body, and particularly those its parts which are also supplied by the fibres of the cerebrum, [are plunged into swoon]. And then from a considerable and impulsive cause we have various species of nausea, vomiting, terrors, toothache, rheumatism, emaciation, panting, cough, proneness to failing of the legs, thighs, feet and abdomen; to say nothing of inordinate appetite, hardness and swelling of the breasts, indolence, and other symptoms. For when the menstrua are retained, there is no other way open than that towards the breasts; no way namely, for the serum, water, and fat devoid of spirits, whence arises the milk. Hence the breasts swell as the menses cease.* *Moreover the soul, which lives in the principles of all actions, and which views ultimates and means as being present in the end, regarded as though it were the effect, so disposes the several operations that they may follow each other in their own order,—as from the first initiament of the embryo in the womb, or from the first stem, so to the last.*

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[1] Cf. App. n. 7-8.

APPENDIX

1–2

APPENDIX

FROM THE WORKS OF MARTIN SCHURIG[1]

Embryologia.[2]

1. Does the Fetus Live Its Own Proper Life? This is a disputed question among philosophers and physicians. The opinion of the peripatetic philosophers and of the old physicians was that the fetus lives one common life with the mother, since it enjoys no respiration.—Others assert that it lives its own proper life, since it lives in the womb even after the death of the mother (I, iv, 2 § 2–3). Many cases are cited where the fetus does not die with the mother. Boerhaave relates one of a fetus who survived half an hour after the death of the mother.[3] Similar to this are the cases of Scipio Africanus, Cæsar, and Manlius; of Gebhardus, Bishop of Constance, and Burcardus, Count of Lintsgow, who was nicknamed "Ingenitus" (unborn) [because he was cut out from the womb of a dead mother]; —of Sanctius, King of Navarre, of whom it is said that he was born after the death of his mother [at the hand of Saracens].—Thomas Bartholin tells of a fetus born two days after the death of its mother.—Many cases are given by other authors.—Cases also of dead fetuses being born while the mother was saved.—In such cases the fetus does not always corrupt (I, iv, §5–10).

2. The Vitality and Animation of the Fetus in the Womb. The ancient, and some modern authors, agreeing with Aristotle in ascribing to man three souls, were persuaded that the fetus remains in the womb for some time without a soul, and that the rational soul is infused after the final completion of the fetal organisation; for according to Aristotle, the embryo lives the life, first of a plant, then of an animal, and lastly of a man.—Some of the more modern authors give the time when the fetus begins to be animated, as the third day after conception; others say the fifth, sixth, seventh, and up to the fortieth; others again give the time as

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[1] In the original MS. these notes from Schurig follow immediately after the work on GENERATION. They occupy seven closely written pages, the last page being notes from Schurig's CHYLOLOGIA, used in our author's ANIMAL KINGDOM, vol. 1, n. 93. The rest of the notes are all on the subject of generation, but only such portions of them are here translated as more directly bear on the present treatment of that subject; the others are briefly referred to in brackets.

[2] The words in black letter give the title of the work quoted.

[3] We are unable to find any mention of this case in Schurig; but he gives several cases from other authors where the infant was safely delivered after the death of the mother, including one from Sennert where a living infant was delivered less than an hour after the mother's death (*Embry.* I, iv, § 5).

[thirty days for males, and] forty-two for females, etc.; some say that the rational soul is not infused until the third and fourth month, etc.—On the other hand some authors state that the fetus is animated immediately at conception; this is the opinion of Sennert.—Michael Albertus and others maintain, according to Bohn, that the rational soul is present at the first moment of conception;—Goelicke also, who says that to talk of a soulless living fetus is to speak contradictions (II. ii § 1–6).

3. The Respiration and Suction of the Fetus. Does the fetus in the womb breathe? Hippocrates, Galen and others, among whom is Gregory Nymannus, affirm that it does.—Some say that it breathes through other than the customary channels. Thomas Bartholin adduces various arguments to show that it breathes through the pores of its membranes, with the constant assistance of the womb, the air being contained in the liquor in which the fetus swims (II, iii, § 1–2). Many cases are given where the infant survives [without external respiration] for some hours after birth while still enclosed in its membranes (§ 14). That the fetus in the womb sucks with its lips is affirmed by Hippocrates and Harvey (§ 16).

4. The Crying of the Fetus in the Womb. Many cases are given from Weinrich, Sennert, Camerarius, Thomas Bartholin, Borelli, Bohn, Needham, etc. (II, iv, § 2–3). Some say that a cry in the womb presages some evil;—others deny its existence.—Sundry causes for it are given.—Christopher John Lang says that it is nothing but a rumbling or murmuring in the mother's abdomen [which deceives the bystanders; or, if it is really a cry, that it is caused by the rupture of the membranes and an unnatural inflow of air through the os of the uterus; and therefore, its being taken as a prophecy of evil is not without foundation] (§ 7–9, 12). The fact of the cries is confirmed by cases in mice, whelps and chicks (§ 16–18). Some affirm that the fetus in the womb laughs,—and even talks (§ 20–21).

[Here follow notes on the Diseases and Corruption of the fetus in the womb.]

5. The Fetus Outside the Womb.—In the cavity of the abdomen, see the Acta Eruditorum Lipsiæ, 1703, Feb. p. 77; 1718, Jan. p. 15;—under the omentum; in the Fallopian tubes (various cases are given in Syllepsilogia);—in the abdomen, as the result of rupture or corruption of the uterus.—Cornelius Stahlpart van der Wiel cites two cases where the fetus was found in the abdomen, having fallen thither when the womb was ruptured. In one case the feet were extended towards the left hypochondrium (III. iii. § 2, 3, 5, 6). A case of a tumor or protuberant vesicle in the cervix, found to contain a fetus.—David Lawrence Ebersbach gives a case of a human fetus found in the bladder; see the Ephemerides Academiæ Naturæ Curiosorum, Cent. V. Obs. 20.—A fetus found in the groin;—in a mole or polypus of the womb;—in the placenta.—But fetuses found in a mole, the placenta, etc., are very small, hardly exceeding the size of the ring-finger (III, iii, § 12–17).

[The remaining notes from *Embryologia* are on The Time of Birth, Abortion, The Signs and Causes of Birth, Birth After the Mother's Death, Plural Births, Unusual and False Births, Prolapsus of the Uterus, Delay of the Fetus, The Cesarian Birth.]

Syllepsilogia

6. THE MODE OF CONCEPTION. Some ascribe the whole of the fetal material to the male seed alone;—others, to a mixture of the male and female seed.—The seed of woman is not true seed, but is a liquor secreted by certain glands of the vagina called prostates (I. i. § 2, 3, 6). That the fetal material comes from the ovum is denied by some and affirmed by others (§ 8 *seq.*). Many authors doubt whether there is any seed in the Fallopian tubes, since another kind of humor has been observed there.—Some assert that a genital aura penetrates to the ovary through the tubes.—Some call this aura the spirituous particles of the male seed;—others the genital spirit.—Others again, say that little worms ascend through the tubes;—but this is denied.—Some declare that the male seed is carried to the ovary by means of the uterine bloodvessels;—others, that it goes through the porous walls of the uterus.—Still another opinion is that the primitive formative is a plastic force (I. ii. § 3–14). Some maintain that conception takes place in the uterus, not in the ovary.—As to the fecundation of the ovule, some say it is effected by fermentation;—others, by a kind of motion; others ascribe it to the soul, which is the architype and a spiritual force (I. iii. § 2, 8–10).

THE OVA. There are ovules that are perfected;—and ovules that are in course of formation (I. vii. § 7–8).

THE CONCEPTION OF MALES OR FEMALES. Opinions differ as to whether a male or female child can be begotten at the father's will (I. ix. § 8). As to whether the difference in sex arises from the ovaries;—or from the imagination of the mother (§ 4, 9).

[Here follow notes on Sterility, Twins, Superfetation, and Embryotokia or a fetus within a fetus. Examples are given from the Animal, Vegetable and Mineral Kingdoms.]

7. THE SIGNS OF PREGNANCY. These signs are indeterminate.—The signs given are: Dryness of the genitals;—closure of the internal orifice;—horror, lassitude, etc.;—suppression of the menses;—symptoms in the eyes, etc., such as headaches, darkening of the eyes accompanied with giddiness; darkening and weakness of the eyes, etc.;—according to Hippocrates, the effects of a dose of hydromel;—the urine;—varicose veins;—the blood and pulse;—milk and the breasts; swelling of the uterus;—motion of the uterus and fetus (V. i. § 4, 6–17). But doubts are raised against these signs;—against hemorrhage as a sign;— against spots in the face.—Against the milk as a sign;—for milk is sometimes found in virgins;—in old women;—in males;—many cases of this kind are cited; such cases are also found among men of the new world;—and in male animals;—such as goats.—Cases where there is pregnancy without milk

(V. ii. 12–19, 21). There are signs peculiar to individuals, as, sudden swelling of the veins during the first months, on the inner side of the thigh; diarrhea, mid-day sleep; sweating on one side of the body [excessive salivation]; antipathy to eels; epilepsy. But these are signs peculiar to some women, but not common to all. (§ 26.)

8. THE SIGNS OF SEX. False Pregnancy. The symptoms of gravid women. The Affections of the Animus, and the imagination of pregnant women. [Under this last head follows a long list of birth marks that have been observed; also marks in animals.] Blemishes occur at the time of the flowering of fruit trees.—Beautiful infants resulting from the mother's gazing at pictures.—The likeness of children caused by the mother's admiration of herself or her husband (V. ix).

Parthenologia.

9. THE TIME OF PUBERTY. The word puberty signifies the hairs on the region of the pudenda.—Authors differ as to the time of puberty variously setting it at from 12 to 18 years; but there is no set time.—Women come to puberty more quickly than men. The termination of puberty is uncertain (I. § 1, 2, 4, 5, 7). [The Signs of Puberty. The Time of Matrimony.]

10. THE CAUSES OF MENSTRUATION. Plethora arising from inactivity. Galen and others ascribe it to the colder and more humid state of women; but this is refuted by many authors.—That it arises from superfluity or exuberance of the blood, is refuted by De Graaf. There are, moreover, a variety of opinions on this matter (II. i. § 5–8). Does menstruation arise from the moon?—from the moon by fermentation? Both affirmed and denied (§ 12–15 *seq.*). From fervor or intrinsic motion? (§ 21.) Some ascribe it to the due casting off of superfluous blood; others to nature;—but the real cause seems to be uncertain (§ 24–25).

THE SEAT OF MENSTRUATION. Do the menses flow through the fundus of the uterus?—From its cavity?—From the vagina?—From both fundus and vagina? From the arteries or from the veins?—From the ducts of the uterine glands? (II. ii. § 2–9, 11–15.) The opinions cited greatly vary.

[The rest of the notes from *Parthenologia* deal with unusual and pathological cases, etc., and the signs of virginity, etc.]

Spermatologia.

11. THE ESSENCE AND MATTER OF MALE SEED. Is there a difference between the genitura and the seed? Some authors derive the matter of the seed from the nerves;—others from the chyle;—and serum (§ 5–7). Is the secretion of seed effected by a ferment? (§ 12.) Authors say it consists of a two-fold matter: one, gross, and visible, called by medical men the genitura, and the other, like spirit.—Others give the seed a three-fold matter [a spirituous from the testicles, an aqueous from the vesiculæ seminales, and an oily from the prostates] (§ 13, 15). The color of the

seed: white, black,—saffron.—Its substance: thick, watery.—Its odor: fishy; savoring of foods; like anise; fetid.—Its spirit (§ 16–21). Worms in the seed.—Petrified seed (§ 23, 25). Flatus through the penis in place of seed;—blood (§ 28, 31). Involuntary emission;— purgatives taken by the male enter with the seed;—so also poison.—Is the soul in the seed? (§ 32–35.)

12. Use and Generation of Seed. In relation to the offspring;— to propagation (IV § 1–2). Is this from the vermicelli? various conflicting opinions (§ 4 *seq.*). Tubular conception, various cases.—In animals ova have been seen impregnated with the seed (§ 7, 8 *seq.*). By the seed are communicated to the offspring, hereditary diseases, virtues and faults; —lameness;—sweating;—hernia;—erysipelis;—headache;—calculi in the lungs;—vomiting;—melancholia;—epilepsy;—difficult deglutition;—paralysis of the fingers;—shaking of the head;—blindness;—absence of eyes; —hereditary diseases in grandchildren (§ 18 *seq.*). Hereditary diseases come also from the nurse's milk (§ 42).

13. Coition. Without coition there is no conception (V. § 3). Great salacity, and frequent coition.—Salacity induced by drugs;—excited by scourging and blows;—the stinging of nettles (§ 18 *seq.*). *From excessive venery* come: loss of mind; drying up of the brain;—feebleness of the nerves; —apoplexy;—palpitation of the heart;—syncope;—epilepsy;—scirrhus of the testicles;—loss of memory;—blindness;—sweating on one side;— acute fever;—gout;—bloody cholera;—the venereal disease;—death (V. § 26–41). *Too little venery is hurtful.*—From it comes anorexia, or nausea at sight of food; delirium;— madness;—impotence;—epilepsy;— death (§ 44–49). Therefore *moderate coition* is useful;—as preserving the health;—in cases of catarrh;—dysentery;—excessive menstrual flow;— delirium;—melancholia approaching to mania;—hysteria;—nymphomania or uterine fury;—chlorosis or green sickness;—the white flux;—gonorrhea, the venereal disease;—tumor in the testicle;—toothache;—scorbutus;— fevers;—epilepsy;—pimples (§ 50–67). *Contagious coition* (§ 68).

[Signs drawn from the seed. Castration, Circumcision, Hermaphrodites, Change of Sex.

[Then follow notes from *Gynæcologia* dealing with female salacity and coition; after which come notes from *Muliebria*. The latter are almost all included in the quotations from Schurig prefixed to Chapters X–XIII.]

THE BREASTS

The Breasts.

1. **Winslow.** (*Exposition Anatomique.*) The middle part of the breast lies almost opposite the bony extremity of the sixth true rib on each side. In children and men the breasts are nothing more than cutaneous tubercles like soft warts of a reddish color, called nipples or papillæ, which are surrounded by a small round circle or disk, more or less brownish in color, termed the areola. In females at the age of adolescence there is added a more or less rounded protuberance, having the papillæ and areola in its center. This protuberance is called the mamma or breast. It increases with age, and becomes quite large in gravid women, in women who have borne children, and in those that give suck. The *Body* of the mamma is partly glandular, and partly fatty. It is a glandular body intermingled with an adipose membrane, the cellular pellicles of which support a great number of bloodvessels, lymphatics, and serous or lactiferous ducts, together with a multitude of small glandular clusters depending thereon. The whole structure is closely shut in between two membranes continued from the pellicles. The inner membrane, which constitutes the fundus or base, is thick, almost flat, and adheres to the pectoralis major muscle. The second or outer membrane is thinner, forms a kind of particular integument for the body of the mamma, is more or less convex, and adheres closely to the skin. The adipose body of the mamma is spongy and more or less interlarded with fat. It is a collection of membranous pellicles, which by the disposition of their outer sides form a particular kind of membrane in the shape of a bag in which all the rest of the adipose body is enclosed. The outer portion of this bag, or that which touches the skin, is very thin; while the side next to the pectoralis major is thick. *Lactiferous Ducts.* The glandular body contains a white mass which is a collection of membranous ducts,

narrow at their origin, broad in the middle where they form the chief constituents of the white mass, and again contracting as they approach the papilla or nipple, near which they form a kind of circle of communication. The *Areola* is formed by the skin, the inner surface of which sustains a great number of glandular corpuscles, called by Morgagni sebaceous *glands*. They are visible also on the outside, where they form little flat eminences or mounds distributed round a circle. These eminences or tubercles, are each perforated by a small hole through which may be squeezed a sebaceous or cheesy matter more or less liquid. Sometimes this is a serous liquor, sometimes a milky serum, and sometimes pure milk, especially in nurses. [I have seen both serous and milky drops come out at the same time.] This leads me to think that these tubercles communicate with the lactiferous ducts, and that they may be regarded as little auxiliary nipples which supply any lack in the true ones (*Tr. de la Poitrine*, n. 7–16).

2. The *Papilla* or nipple varies in size, in general according to age and temperament, and in particular according to the different states of females. In pregnant women and those who give suck, it is pretty large and in general is longer than it is broad. Its texture is spongy, elastic, and liable to changes of consistency in respect to firmness and flaccidity. It seems to be made up chiefly of a number of ligamentary fascicles, the extremities of which form the base and apex of the nipple. These fascicles appear to be slightly folded along the whole length of their fibres, so that when stretched the folds are obliterated but at once return as soon as the traction ceases. Between the spongy and elastic fascicles lie seven or eight particular tubes at small distances from each other and all running in the same direction. Around the base of the nipple, these tubes terminate in the irregular circle formed by the assembling of the lactiferous ducts; and at the apex they open out by an equal number of small and almost imperceptible orifices. The tubes are closely bound in with the elastic fascicles, and are folded in like manner. The *Body* of the nipple is covered by a fine cutis and by the epidermis. Its outer surface is very uneven by reason of a number of slight eminences and irregular rugosities, among which those near

the circumference seem in some subjects to have a transverse or annular arrangement, which however is much interrupted. [This disposition or direction seems to be owing to the elastic folds of the fascicles mentioned above. The excretory tubes are wrinkled in the same manner as the fascicles, and] these wrinkles or folds, are like so many valves [which hinder the milk contained in the ducts from flowing out; but when the nipple is drawn out and elongated the tubes lose their folds and the passage becomes straight]. The milk may be squeezed out by merely pressing the breasts. (*Tr. de la Poitrine*, n. 17–21.)

3. The *Arteries* and *Veins* of the breasts or mammæ are called the mammary vessels; the internal mammaries are branches of the subclavian, and the external, branches of the axillary. These vessels communicate with each other, with those near them, and with the epigastric vessels. The *Nerves* come chiefly from the costals by means of which they communicate with the great sympathetic nerve. Milk has been observed coming from the breasts of men, and Winslow has seen it squeezed out of the breasts of one of his own brothers, an infant of about two years of age. (*Ibid.* n. 22–24.)

4. HEISTER. (*Compendium Anatomicum.*) The size of the breasts varies, being medium-sized in virgins, largest in women who are pregnant, have borne children, or give suck, and smallest in girls before puberty and in old women. Their size varies also in different countries. They begin to grow or swell up about the fourteenth or fifteenth year; and to decrease in size about the fiftieth. The *Papilla* or nipple is of a cavernous substance, almost like the penis; hence in like manner it is capable of becoming erect and swollen. It consists of reticulated and sensitive nervous fibres, numerous bloodvessels, the extremities of the lacteal tubules and epidermis. The little foramina or orifices of the lacteal tubes are from seven to ten in number. The *Areola* is beset with small glands. In addition to the epidermis, delicate cutis, and fat, the breasts are composed of a peculiar whitish glandular structure not unlike the substance of the udder in quadrupeds, occupying the middle of the breast and everywhere surrounded by the abundant fat which makes up the greater part of that organ.

Over against the center of the structure stands the papilla or nipple. The globose bodies delineated by Nuck and Verheyen, and described by them as being distinct glands, are not really glands, but fat. Amid the glandular substance are set lactiferous ducts which originate in the glandular substance; are joined together by anastomosis; become large in nursing women and dilated into sinuses and little chambers, as it were; collect the secreted milk; and communicate with the arteries and veins. In girls before puberty and in old women these parts are scarcely to be distinguished. The veins and arteries called the mammary vessels, arise from the subclavian, intercostal and axillary vessels. To these Wharton adds lymphatics. (n. 250.)

5. Boerhaave. (*Institutiones Medicæ.*) The arteries of the breasts communicate with the epigastrics; they then go off into remarkable spiral contortions and little nodes, and at last put forth small lactiferous tubes in straight lines. There is a free passage from the arteries through the lactiferous tubes to the nipple and back again from the nipple through the lactiferous tubes into the arteries. The areola of the nipple is beset with sebaceous lacunæ and sometimes with lactiferous ducts.—Pain, hardness and tension of the breasts, erection of the nipples, and the dripping of serum in the evening, sometimes happen during pregnancy,—all of which phenomena increase more especially during the three days succeeding the birth of the child. The drying up of the milk increases the lochial discharge. The color, smell, taste, and quality of the food are discernible in the mother's milk. The milk varies in quality according to the food and drink that has been taken. It is best four or five hours after eating; after twenty-four hours fasting it is salty, unpleasant, yellowish, and soon becomes fetid. (n. 688, 690.)

6. Morgagni. (*Adversaria Anatomica.*) Besides the nipple, males are also furnished with mammary organs of secretion (V. § 1, p. 3). Ruysch has delineated the little nervous papillæ [found on the nipple and also in the areola, which render those parts extremely sensitive] (V. § 3, p. 6). I have always found a peculiar glandular substance in the breasts, compacted into a single large body, whose center pretty nearly

corresponded with the nipple. It was of a white color, had a somewhat uneven surface, and was of a hardish substance offering some resistance to the knife. Within this substance when full of milk, were seen certain cells as it were, which were also full of milk, and which belonged to the lactiferous ducts; and therefore Riolan [describes the breast as a single and continuous glandular body]; and Wharton, as the largest of the glands, and as consisting of a glandular, spongy, and uninterrupted parenchyma.[1] This glandular body is everywhere contained between two soft layers of fat, the fat being placed both above and below (V § 4, 5). I have noticed that to the several tubercles of the areola, run an equal number of lactiferous ducts, and that they are so dilated within the tubercles, that the build of the latter is mostly due to the dilatation of these ducts and to their projecting beyond the plane of the areola. At the apex of the tubercle, the duct contracts into an excretory orifice and there opens outwards.—Morgagni calls these tubercles sebaceous glands, because something very like a sebaceous matter may be squeezed from them (V. § 7, 8). He further observes that the glands of the breasts do not consist of numerous minute and separate glands, as authors frequently figure them, but that they all form one gland, the fat being placed not within this gland but above it and beneath. (*Index Rerum*, p. 20.)

7. Nuck. (*Adenographia Curiosa.*) Arteries are distributed to the breasts in infinite ramifications. The internal arteries rising from the subclavian run within the thoracic cavity, where, having reached the middle region, they perforate the muscles between certain of the ribs,[2] and by their numerous turns and twists form in the breasts the knots of the conglomerate glands (Cap. II p. 11). Mercury injected into one of the orifices of the nipple, passes not only into the lactiferous ducts, but also into the arterial vessels continuous with these ducts, showing that the ducts have no valve (p. 12). In Nuck's figures I and II, these ducts are represented like

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[1] *Parenchyma*, a texture composed of agglomerated globules, united by areolar tissue, such, for instance, as the liver.

[2] Nuck is here referring to what are now called the anterior perforating branches of the internal mammary arteries.

the branches of a tree. They are all united by mutual anastomoses. (p. 16.) Nuck saw fibres both large and small, firmly attached to the integuments of the nipples on every side. The smaller fibres maintain a surprising order and arrangement. The series of the fibres is two-fold,—the one set being composed of somewhat large retiform fibres, and the other of fibres that are exceedingly minute.[1] The latter are perforated with orifices of various forms and are everywhere connected with the larger fibres. (Cap. III, p. 24.)

7a. [Leeuwenhoek. (*Continuat. Arcan. Natur. Detect.*, Lugd. 1697.) Leeuwenhoek took some sweet milk with which he mixed a little coagulum of milk. Putting some of the mixture under the microscope as quickly as possible, he saw a number of round particles coagulated, and between them and at their sides, an incredible number of other and smaller particles. The smaller particles which floated in the fluid were different from the coagulated particles, both in shape and substance. Moreover, he saw floating in the liquor, pellucid globules of various sizes, the smallest of which were equal in size to the globules which give the blood its redness, while the larger, which were no less pellucid, were twenty-five times bigger.] (p. 171.)

7b. [Bartholin. (*Anatome.*) After partaking of food and drink, nursing women immediately feel an inrush of the milk and a filling up of the breasts; and therefore they are cautioned not to eat too soon before nursing, lest a crude milk be given to the suckling. If the nurse drinks milk with an infusion of saffron, in half an hour the milk coming from her breasts has the odor, taste and color of saffron. Blood frequently follows the milk when the breasts are sucked inordinately (Lib. II, cap. i, p. 328-329). Sometimes, though rarely, milk is found in virgins, according to Bodinus, Joacim Camerarius, P. Castellius, Al. Benedictus, Ch. a Vega and others. In our own [province of] Scania, a virgin was found with milk, and it was proved by witnesses that her little brother also had milk in his breasts, and that this was a peculiarity in the family. The nipples of new-born infants pour out a serous milky liquor. In fleshy men with well developed breasts, a milky humor is found not unfrequently, especially if frequent suction and rubbing be used. Aristotle and also Matthiolus tell of a he-goat which gave milk. Abensina saw a large quantity of milk drawn from a man; and C. Schenkius tells of a man who gave milk from his youth up to fifty years of age. John Rhodius, Santorellus, Walaeus, Nicolaus, Gemma, Vesalius, M. Donatus, and Aquapendens all tell of cases of a father's milk nourishing his motherless children. We ourselves have seen in Scania a boy with milk in his breasts, and Cardanus relates the same of a man thirty-four years old.] (p. 333–334.)

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[1] See n. 18, note.

INDUCTION.

8. *Whatever material lies in the blood, that is, in its red globules and its surrounding but genuine serum, must also be contained in the milk, in order, namely, that the latter may give nourishment to the tender infant, and that from it the infant may obtain the blood that circulates so abundantly in its vessels. Therefore if the least portion of material be wanting the infant will be imperfectly nourished, inasmuch as it uses no other food but the milk.* That the milk contains every material that lies in the blood and its serum is evident enough from common experience and analysis. For in the milk is contained fat, which goes off into cream; also the serum which separates in large quantities from the fat; and together with these, all kinds of saline particles, urinous, sulphureous, nitrous and alkaline. The serum turns sour, and sometimes clots, and in cheese it forms a close mass,—which facts show that it contains a quantity of alkaline matter. But to know from inmost grounds what the milk must contain in order for it to embrace all the materials of the blood, it is imperatively necessary that we know what the blood is, what saline elements enter into its globules; what the serum is, and especially what the saline particles that compose the genuine serum; and lastly, what the fat is, and what the manner of its concretion from the resolved blood and its serum; and hence what are the elements contained in the more fatty part of the milk, and what those contained in the casein, etc. And so the whole science of chemistry would have to be known before we could rightly comprehend this transmutation of blood into milk. For the present, it suffices to say that the blood contains the prime elements of all solids and fluids, and the very principles of every order and degree. Thus it is able to be the parent of all things that can possibly exist in the world of humors, and

is therefore the promptuary and treasure-house of all things in its body. See Trans. I [n. 3 *seq.* 59, 61].

9. *In the milk*[1] *therefore there must be a combining of fatty elements with watery; which is brought about by salts of different kinds, all being copulants between the two. It is requisite, however, that this copulation be somewhat slight and loose, in order that the parts may be readily again resolved into their principles.* It is well known from chemistry that a fatty or oily element will not of itself unite with a watery, but must be united by means of saline copulants. The copulants themselves are also known. The fact that in milk the copula or bond is exceedingly slight is evident from the spontaneous resolution of milk when left in a vessel, its resolution, namely, into cream,—a white substance of comparative consistency,—and a sourish fluid; also from its ready resolution when, merely by motion, it is turned into butter, or by heat, into various kinds of curds. Moreover this loose coherence of the parts has also been discovered by the microscope. For milk has been seen to contain globules, large and small, held together by the aid of salts, and with the slightest possible contact. Certain lighter and finer globules were also seen rising to the surface, while the heavier sank down; see Leeuwenhoek [n. 7a]. Thus the copulation is extremely slight, and this is necessary in order that when the milk enters into the little infantile frame, and swells the nutritive organs and vessels thereof, which are so soft and tender, it may at once be separated and go off by distinct paths into blood.

10. *Thus the milk is merely a composition and unition of all the elements contained in the blood; and is that fluid into which the blood must be concentrated in order that it may be able to at once turn back to blood and thus describe a kind of circle, as is its wont in the body; for in the body, the blood is perpetually severed into its elements and again compounded. Thus the milk must be a kind of intermediate boundary,—a boundary which the blood in the maternal body regards as its last, and the blood of the infant as its first.* This follows from the nature of things; for whatever is to be converted into blood, and contains in itself all that is in the blood, must also consist of the several parts of the blood, and so must be a middle essence between the mother's blood and the future blood of the child.

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[1] The Latin has *in sanguine* (in the blood).

11. *It is very evident from a multitude of chemical experiments that when oily elements are mixed with watery, even if only slightly, we immediately obtain a whitish fluid similar to milk; for whiteness is the inevitable result whenever transparent parts of divers nature are inter-united without any set rule and form. Thus it follows of necessity that when fatty elements are combined with watery, by means of saline particles serving as copulas or bonds, the result is a humor of a milky color.*[1] This is supported by all the experience of chemistry, for nothing is easier than to give an oily fluid the peculiar consistency of milk by mixing it with essential or other salts. That white is not a color, since the parts therein are not disposed in any ordered manner, see Trans. I [n. 85–89]; consult also experience; for experience shows that chips of glass, ice, and many other transparent and even colored substances, present a snow-white color.[2]

12. *To enable us then to perceive aright the composition of the milk, we must seek it from the breasts and their structure, that is to say, we must inquire how those three principal essences, namely, fat, urinous serum, and the purest matter of the blood, are brought together; for from these or their mixture, results the compound called milk.* The mode in which these essences are distinctly separated from the blood and enter the machinery of the breast by distinct paths and at last come together and produce the milk, cannot be better cleared up than by a full examination of the breasts. But we cannot enter further into the chemical theory and show the source and nature of fat, the nature of the serum, and that of the inmost essence of the matter of the blood; for this would demand an entire course of chemistry.

13. [First.] *That an abundance of fat streams to this humor which is about to become milk is evident from the fatty pellicles and layers that surround what is called the glandular body of the breast, or its oval center; for the fat hems it in on all sides, and by its layers the adipose matter is continued all the way to the interiors where arise the lactiferous ducts.* From the circumstance of

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[1] See the author's Principles of Chemistry, p. 129, 131.

[2] See the Fibre, n. 58.

the surrounding fat, and of the continuation of this fat into the middle or enclosed space, no other conclusion is possible than that this is the source of the fat which appears in such abundance in the milk, and separates from it spontaneously. For the cellular tissue which contains the fluid and yellow fat is continued by pellicles and fine ducts all the way to its center; and since this fat is of a purer nature, and as it were the prior essence of fat, and of a nobler quality than common fat, it must stream to its place through finer ducts, and as it were continuous pellicles and vesicles. Common fat, or that which constitutes the adipose membrane, is too gross to be entirely serviceable for this work, and therefore by means of the above ways and passages, it is brought to the spot in a more purified state. This is the reason why this body, lying between the layers of fat, is sometimes called a glandular body consisting of numerous clusters of glands, and sometimes a single great gland [n. 4, 6]. It is well known that a fatty humor passes through the purer ducts and vesicles which is more subtle than the common aqueous humor. That the fat is continued to the interiors is shown by Winslow. [n. 1.]

14. [SECOND.] *The serous part of the milk together with interfluent saline, acid, alkaline, and urinous parts, comes immediately from both the internal and external arteries. And since these arteries arise from the subclavian and axillary vessels, therefore blood freshly come from the heart is brought to the breasts immediately, and before it reaches the emulgents and their general emunctory organs, the kidneys; and the vilest portion being rejected on the way by means of the winding of the vessels, it arrives in the breasts with the essence of the fresh and nearly crude chyle. This is the reason of a number of phenomena related concerning the milk of nursing women and the changes which it undergoes.* The blood coming fresh from the heart, abounds with an infinity of alimentary parts, including also those of a viler sort, which [ordinarily] are unloaded just below the diaphragm by means of the emulgent vessels and the kidneys. But the subclavian and axillary artery is[1] situated above the diaphragm, and is the first vessel to intercept this quantity of fresh blood, including also its more impure portions; and there-

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[1] The axillary artery is a continuation of the subclavian.

fore a smaller quantity of urine and of the lochia is passed off in nursing women, than in the same women immediately after the retention of the milk. This, moreover, is the reason why the milk has sometimes the smell and taste of the food and drink last partaken of; and why better milk is obtained three or four hours after a meal than at any other time either earlier or later; and why it becomes too sour to be good after the mother has fasted for several hours; also why, as Bartholin narrates [n. 7b], a rush of milk is sensibly perceived by nurses immediately after eating; not to mention several other phenomena, all having the same bearing. Especially does it show why the daily practice of nursing causes a livid appearance in the arteries close to the breast, which seem to be turgid with serum, rather than with blood. That arteries secern or separate the serum but retain the blood is clearly manifest during anatomical investigations; indeed nothing is clearer, see Trans. I [n. 199 iv, n. 221]. But lest the foulest parts also should be derived into the essence of the milk, these mammary vessels, both internal and external, are brought thither by many windings, in order, namely, that they may separate and cast off the more defiled portion of the blood. For the internal mammary first passes through the pectoral muscle and so, finally purified of these dregs, flows in with a genuine and suitable serum. That the like elements are contained in the milk [as in the serum] is well known even to the unlearned, from the quantity of sourish fluid which remains after milk has been creamed. That it also contains alkaline, saline, and urinous elements, is evident from the elements themselves coagulated into various kinds of curds and cheeses; for in these there is considerable consistency; moreover what remains of the milk, that is, its final appearance in the form of cheese, has a bitter taste and does not dissolve by the application of heat, but gradually runs into a soft semi-fluid mass.

15. [Third.] *From the thorough commingling of these two essences or humors, there results an essence which is of a milky color, but which nevertheless is not genuine milk, until besprinkled by the purer material, that is, the prior elements or saline principles, which lie deep in the bosom of the blood. This is done not only in the adipose follicles or cells, but also in the follicles of the* *central body, which appear like glands or glandular clusters; and also during the whole passage through the lactiferous ducts all the way to the nipples.* It is clear from the anatomy of the breasts, that innumerable capillary vessels surround the fat-cells and sprinkle on them a sanguineous juice which is more noble and interior in the degree that the vessels are the more pure. Moreover in the inner parts of the breasts, according to the testimony of Nuck and Boerhaave [n. 5, 7], these vessels by wonderful contortions and spires, form nodes from which can expire none but the purer essence of the blood. In this way the third essence of the blood is poured in, which though of a purer nature is yet its material essence. It is clear from the composition of the blood, see Trans. I [n. 29, *seq.*[1]], that the blood globule is made up of the purest saline elements and principles which enter into its pellucid globules and strengthen their structure; also that it contains saline elements of the second order or degree, otherwise called volatile, urinous, and sulphureous salts,[2] those namely, which nicely combine the six primitive globules of the blood into a single globule, see Trans. I [n. 69–79, 95, 96]; and moreover, that in the middle of the blood globule, there is a saline corpuscle having six concave sides (Trans, I [n. 70, 77]). This then is the constitution of blood in its several degrees. That these saline elements may be proffered to the blood to the end that it may coalesce into a globule, there is required a watery serum rich with elements of this kind, and which shall serve as their vehicle, see Trans. I [n. 47, 48, 49]. It follows therefore, as a clear consequence from what has been said above, that all the elements actually contained in the blood as well as in the serum which serves as their vehicle, are also contained in the milk. For the grosser kind of fat is nothing else than the material of the saline parts or elements of the second class, that is to say, is nothing else than those urinous and sulphureous elements which, as can be shown by innumerable experimental proofs, are fitted into the globules, where they occupy the surface, while a little volume of ether occupies the cavity.

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[1] See particularly n. 91 and references.

[2] The saline elements of the first order or degree are common salt, and pure acids. 1 E. A. K. n. 76.

But since saline and alkaline elements of a grosser sort are also frequently inserted into this fat, therefore, before being conveyed into the blood, it is purified in the manner noted above. But the purest principles which are freshly distilled by the arterial capillaries, are a primitive oil as it were, which crowns the mixture and thus perfects the essence of the milk. All these loosely combined elements are again resolved into their primitive parts and go off to form a large supply of blood, as observed above.

16. *But lest the spirituous essence of the blood should also pass off into this milky substance, it is provided that the arteries shall make innumerable contortions and nodules, and that there shall be an infinity of veins opening out from the little fat-cells, and also from the other follicles and glands and from the lactiferous ducts, whereby anything of the spirituous essence that may be secreted in company with the other elements is at once greedily re-absorbed.* There is also an abundance of lymphatics in other parts of the breasts, and these, together with the veins which manifest their presence everywhere in the minutest pellicles and follicles and finally in the nipples themselves red with their abundant blood, and also in the areola, diligently seek out any extravasated essence of this kind, and whereever they come across it greedily snatch it up; for nothing is more friendly to the blood than this same essence, so that, with the blood as it were inviting, it flows back almost spontaneously and with a certain force not unlike the magnetic. For were the milk to be rich in spirits also, the nurse might easily swoon away after a few moments of suckling. Nor is there any need for the infant to draw and borrow from its nurse alien spirits as it were, since its own brain now conceives, prepares, and sends forth an abundant supply. For the infant lives from its own life, and not from the nurse's; and therefore in the latter's milk there is nothing more than merely the material part of her blood.

17. *The vessels, cells and ducts are so formed that whatever is contained in one is common to another and to all; so that each part draws its share from a common lake or stream. Thus it can never fail but that the essence of the milk wherever prepared is of uniform quality.* This is sufficiently evident from the lactiferous ducts which constantly communicate with each other by perpetual anastomoses. The like is true also of the arterial and venous vessels, which for this reason make so many twistings and nodes; and so likewise of the fat-cells with the ducts which penetrate to this center; indeed around the nipple itself there is a circle to which all the lactiferous ducts run. A like arrangement is in use throughout the whole anatomy of the body and in every viscus, especially in the brain,—in order, namely, that the effect may never fail the cause.

18. *But since in all her progress nature regards an end which is both the first end and the last, so also in the breast. For there she regards lactation and thus the life of the new-born infant. Hence she produces the nipple at once before the existence of the breast, and this even in the new-born babe. In course of time, however, she draws out towards the nipple nearly all the arteries and veins of the breast, also the fibres, and finally the lactiferous ducts, concentrating them all in this threshold as it were; for the whole mass of the breast regards the nipple as the terminus to which everything looks.* This is confirmed also by anatomy. For there are as many ducts put forth through the nipple as there are lactiferous ducts in the interior. Each of these ducts, greatly contracted as it is, regards not only its own duct in the breast, but also every other duct,—agreeably to the rule just laid down. Thus the disposition is particular and at the same time general. The way in which the bloodvessels pervade this part is shown not only by its redness, but also by actual dissection; moreover, a double series of fibres invests the nipple in a retiform manner, confer Nuck [n. 7], and the same author's Plates.[1] *And this to the end that when the nipple is touched and fondled by the fingers or lips, and also when it is drawn out by the suckling, a communication may at once be established with all the internal parts constituting the breast; that is to say, not only with the nerves which bind the inmost substances and the vessels, but also with the arteries and veins them-*

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[1] The Plates referred to are figures VI, VII, and VIII of the ADENOGRAPHIA CURIOSA, which show a section of the nipple seen under the microscope. The figures exhibit an intricate network of fibres, and within the meshes of this network a still finer network made up by the interlacement of very delicate fibrils.

selves and consequently with the lactiferous ducts which are subtended by the fibres and vessels and by their membranes. Hence comes erection of the nipple, its proneness to pour out the milk, and at the same time its excitation to the preparation and attraction of new substances for the milk. These are the ends for which the milk is prepared in the breast. For when the ultimate fibrous surface, which is very sensitive, is touched, the touch and titillation is straightway diffused into all the fibres of the entire breast, and therefore at once excites the membranes and vessels, and erects the nipple. And when the arterial vessels also are drawn out,—for by means of the fibres these vessels are then in the state for being drawn out,—they distill their serum, and pour it in, and also put all the lactiferous ducts on a similar stretch; and thus perforce the milk rushes out of its own accord.

19. *The above conclusions are inevitable consequences following from the communication of the fibres and vessels of the nipple with the inmost substance of the breast. As soon however as, by undue expansion and frequent use, the above communication is lessened and the connection becomes lax or loosened, then the nipple grows flaccid; from being red, it becomes livid and black; and the breasts themselves fall down pendulous, becoming very different from what they are in the virgin.* For the substance of the nipple consists of fibres and vessels, and of membranes composed thereof; hence if their connection with the inmost substances of the breasts be relaxed, the necessary consequence is, that the parts which were formerly erected will now collapse, and the blood collected in the vessels of the same part will not so readily find its way back; add to this, that in advanced age, —for example, in elderly women,—with the ceasing of the use and necessity, the close connection perishes, and with the derivation of the blood and its serum to other parts the lactiferous ducts, and at the same time the vessels and fibres, begin to collapse. Furthermore, as age creeps on, the minutest stamina or threads are gradually obliterated and their sides grow together, only the larger channels being left. Hence in elderly subjects, that is in women of about fifty years, the breasts usually become smaller and tend to disappear.

20. *There is also a communication between the breasts, and* *especially the nipples, and the genital members, but it is effected by means of nerves, and has not yet been explored by anatomists.* This is plain from the effect; for the nipples are erected not only by titillation, that is by the causes mentioned above, but also by a secret stimulus of venery. This is well known to everyone, and it can also be confirmed by many proofs. All that is known upon this subject anatomically is that the mammary or costal nerves[1] communicate with the sympathetic nerves, or with the par vagum and the intercostal, and that these nerves are sent to the members devoted to generation. But to investigate the actual communication, it would be necessary to assiduously follow up the fibres[2] from the point of anastomosis and diligently to note their terminations or insertions.

21. *The red areola surrounding the nipple also performs a notable use. For in order that the blood conveyed to the nipple by all the branches may rightly perform its office, it must circulate round about, and this especially during the period of lactation when the nipple undergoes alternate extension and relaxation.* Were it not for this field and gyre, when the nipple is drawn considerably out and again relaxed its large supply of blood would readily rush out of its vessels and so give rise to sanguineous serum; for one vessel is compacted with another, and each is drawn out, extended, and contracted, together with its neighbors. Thus there must be left for it a little gyre wherein it may circulate in the meantime, so that it may enjoy places of asylum and reception. Thus every contingency is provided for. Without the areola, the communication between the vessels of the nipple and those of the breast itself would be destroyed after a few times of nursing, and thus the very purpose of the breasts would be defeated. *Yet its sphere of circulation is so limited that it embraces only the tract*

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[1] Called also the thoracic or intercostal nerves. The particular nerves in question are the fourth, fifth, and sixth intercostals, which communicate with the sympathetic system by rami communicantes. The intercostals, which run between the ribs, must not be confounded with the intercostal which runs from rib to rib and which is now called the gangliated cord of the sympathetic. See GENERATION n. 42, note.

[2] The reference seems to be to the rami communicantes mentioned in the preceding note.

where the lactiferous ducts terminate in glands. For besides their concentration in the nipple, these ducts also have their ends and boundaries around it, that is to say, in certain glands [*in the areola*]. *Whence it follows of mechanical necessity, that in no case are the lactiferous ducts disturbed from their place, but on the other hand, that they always maintain among each other a suitable connection and order.* This would never be the case if all these ducts, thus concentrated, terminated only in the nipple. If, however, their terminations regard also other ends outside the nipple, then they will not be disturbed from their position and mutual connection. This is a matter of pure mechanism. For supposing I were to combine a number of threads into one bundle and not attach each individual thread to any fixed boundaries in other parts, they would then be easily shaken out of their mutual connection. That these glands are the extremities of ducts is plainly declared by Morgagni [n. 6], and Winslow [n. 1]; other anatomists also are of the same opinion.[1] For almost the same reason holds good of these ducts as of the bloodvessels in the areola. Thus in order that the blood may ebb and flow distinctly into the lactiferous ducts, the nipple is compressed and drawn out, and by this path the blood passes back into these ducts and thus makes a communication with the whole sanguineous texture of the breast. Nay [the glands of the areola] by their unanimous traction excite the lactiferous ducts themselves to severally distill their milk. Thus these glands are auxiliary stores to the nipple, in order that all may be done aright. Therefore sometimes they emit sebaceous matter, sometimes serum, and sometimes milk, either pure or mixed [n. 1]; and they are pierced by little openings or foramina; for without foramina to allow of exudation, they could not subsist, but all communication would at once be lost,—which, however, is maintained intact by fistular passages which afford an outlet. Otherwise they would be blocked up, would soon collapse, and the whole passage would be entirely obliterated.

22. *With respect to the unfolding and folding of the nipple, that is, to the fact that it is destitute of valves, but applies its own rugged tunics to the milk now ready for escape;*[2] *also to the fact*

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[1] See Boerhaave n. 5.

[2] See Winslow, n. 2.

that the lactiferous ducts so communicate with the arteries that no greater quantity of milk is poured in than the need at the extremity, or the force there applied, actually demands, and that the superfluous portion runs back,—all this is a mere mechanical or organic provision, and is therefore evident on mere anatomical inspection. For this reason I do not dwell longer upon these matters.

23. *Furthermore, it is to be observed that the male chest is also furnished and adorned with breasts, nipples, and areolæ, not, however, for the purpose of giving suck to infants but because of a natural necessity, namely, that they may provide these two sides of the chest with a breastplate as it were,—which is all the thicker by reason of the subjacent pectoral muscle; and that, at the same time, they may protect that part of the lungs which lies underneath them, from cold and heat and all other contingencies; and also that by means of this fatty expansion and protuberance, the faculty of action may be given to the muscle and to the arms attached thereto; for when the arms are let go or are waved about in various directions, these parts of the chest readily yield and relax; but without the breasts these actions so necessary to the human race could hardly be carried on.* Fat is naturally gathered up to this place. For when the thoracic, and even the brachial muscles, are in action, the pectoral muscle always coöperates; so that the actions of the thoracic muscles all center in this spot; and therefore an abundance of liquid is collected within the cellular tunic which is the common tunic of these muscles, and also the basis of both breasts. For this reason an abundance of fat cannot fail to be concentrated to this part. And if there be fat, and if the frequent extension and relaxation of this pectoral part be required, it follows that this fat must circulate; that is to say, must be gathered near the cellular texture of the muscle as well as round about under the skin or epidermis. And if this be the circulation of the fat, it follows that it is concurrent with the blood and the ducts; that is to say, that here will be found organs secretory of milk, and which are fixed in the nipples and end there as in their last term. Suppose there were no fat here, and no tuberosity, but only tense skin such as is found in other parts; and then suppose the arm to be stretched backward, or to be moved in labor, embracing, wrestling, or fighting; would not this skin resist, or would it not be at last so stretched out, that when the arms were brought back a great wrinkle or protuberance would appear? Moreover, wherever there is considerable motion the faculty of motion is always supplied by circumjacent fat. Such is the case here with the pectoral muscle. This muscle, moreover, covers that nobler part of the thoracic cavity where lie the lungs; round about are the bones, such as the sternum and vertebræ. This part is intermediate, and thus [if it were not for the breasts] heat or cold would easily penetrate, and would trouble the mechanism and motion of the very heart itself. That in males the breasts are formed not for the sake of milk but as a matter of natural necessity is apparent from the case of the males of other animals, in whom the breasts are situated not on the chest but under the belly. Nevertheless many cases have been collected by writers, where male breasts also have produced milk. Bartholin cites a number of such cases from Bodinus, Joachim Camerarius, Castellius, Benedictus, Ch. a Vega, Aristotle, Matthiolus, Schenckius, Rhodius, Walaeus, Benedictus, Nicolaus, Gemma, Vesalius, Donatus, Aquapendens, Cardanus, etc.; and Bartholin himself tells of similar cases at the present day [n. 7b].

24. *The above points are confirmed by the swelling of the breasts in pregnant women some months before delivery, and particularly during the preceding few days. For the infant now coming to maturity no longer emulges from the mother any great quantity of serous blood through the umbilical vessels, but feeds through the pores of its skin, upon its own liquor amnii. Consequently, the sanguineous serosity of the mother is determined in another direction, and in fact, by the nearest path, namely from the subclavian and axillary vessels to the breasts. And, therefore, lest this supply of serosity be discharged in women as it is in men, through the kidneys and other channels, they have the menstrual flow. It is this part, though in a purer condition that is now expended on the milk; wherefore with the menses comes also the swelling of the breasts.* But since many points here occur which require the confirmation of experimental testimony, I have preferred to touch only lightly on the above particulars and merely to mention them.

THE PERIOSTEUM

THE PERIOSTEUM.

1. WINSLOW. (*Exposition Anatomique.*) The bones of the human body are for the most part covered by a membrane called by the general name, periosteum; but where it covers the cartilages it is termed perichondrium, and where it covers the ligaments, peridesmium. The periosteum in general is a tolerably fine and extremely strong membranous expansion, not equally thick in all its parts, more or less transparent, of a very close texture, not easily yielding, extremely sensitive, and composed of several particular planes of fibres differently disposed, and intermingled with a great number of small vessels and nervous filaments. This membrane does not immediately invest those portions of the bone which are covered by the cartilage, nor those in which the ligaments and tendons are inserted. Nor does it invest those portions of the cartilages which are exposed to friction, as in the moveable articulations, nor those portions of the teeth which lie outside the sockets and gums. The surface of the periosteum which lies next the bones is attached to the latter by innumerable little fibrous extremities detached from all the planes and which insinuate themselves into the pores of the bone. These extremities are accompanied by capillary vessels and nervous filaments which run for some way between the different planes of the periosteum and perforate the inmost plane at the orifices of the pores of the bones. The periosteum is of irregular thickness, but this is scarcely visible on the outer surface; the inner, however, is marked by many impressions produced by the sulci, depressions, lines, and other inequalities on the surface of the bones. To some anatomists the periosteum appears not only as agglutinated to the bones, but also as a bond tight drawn around them; and therefore they have held that it could limit the bone's growth and thickness. Apparently they have examined only certain of the bones, but had they considered those which have concave surfaces, depressions and

inequalities, they would have found only a simple adhesion, without any tension. In places where it is fixed to the bones only by the filaments of its inner plane, the periosteum is easily detached; but this separation is more difficult where the bone is penetrated by the fibres of the other planes likewise, especially when these planes are numerous; and also where it is penetrated by tendinous or ligamentary attachments. The membrane which invests the cranium is called the pericranium, but the part which invests the jawbone is called simply the periosteum. (*Tr. des Os Frais*, n. 59-64, 354.)

2. The pericranium is made up of two laminæ or layers closely united together. The internal lamina, which has been taken for a particular periosteum, covers immediately all the bony parts of this region. The external is termed by some anatomists the true pericranium. The external lamina separates from the internal about the semicircular or semioval plane of the lateral region of the cranium, where it becomes a somewhat strong aponeurotic or ligamentary tent which covers the temporal muscle and is afterwards attached to the external angular apophysis or process of the frontal bone, all the way to the mastoid process. [Between the two laminæ, as they separate in this place, is inserted a large portion of the temporal muscle.] The rest of their interval which does not give insertion to the muscle is filled with a cellular and fatty substance between the lower portion of the muscle and the zygomatic arch. At this place the aponeurotic hood is seen to join the external lamina, and they both communicate with aponeurotic expansions of the neighboring muscles, that is, of the sterno-mastoid, masseter, and zygomatic. (*Tr. de la Teste*, n. 199-201.)

3. HEISTER. (*Compendium Anatomicum.*) The periosteum is a nervous vascular membrane, acutely sensitive, immediately investing the internal and external surfaces of all the bones, excepting only so much of the teeth as stands above the gums, and those places in the bones where the muscles are inserted. It constitutes the rudiments of the bones in the fetus; is the organ of secretion for the bony matter as the adipose membrane is for the fat; and from it the bones receive accretion, increase, and nutrition, since its bloodvessels

penetrate the bones in innumerable places,—as seen in the bones of children. When it is injured exostoses,[1] tophi,[2] and caries, etc., are the result. Its thickness varies in different parts. The inner layer is much thinner than the outer and nourishes the bone. It receives bloodvessels and nerves through certain canals in the substance of the bones, by which it communicates with the marrow. (n. 186, 187.)

[1] Tumors on the surface or in the cavities of the bones.

[2] Formations of hard calcareous matter, particularly at the joints.

INDUCTION.

TREATING ALSO OF THE SUCCESSIVE FORMATION OF THE PARTS IN THE LIVING BODY.

4. *First of all is delineated the cortical substance as the primitive and purest brain. These cortical substances are conglomerated together, whence arises the first effigy of a brain. The form and determination of this conglomeration is what produces the parts named cerebrum, cerebellum, medulla oblongata, and medulla spinalis.* Of these however one exists before the other,—the cerebrum, namely, before the medulla oblongata and spinalis; nay, even the cerebellum comes after the cerebrum, as may be seen in Malpighi's treatise on the Incubated Egg.[1] *Afterwards from these beginnings fibres are put forth as appendages, but which do not yet venture to proceed to any distance. The fibres are what form the whole of the little animal frame; thus the brain by means of the fibres, flows into the entire system, wherein there is nothing existent except the fibre and its spirit; that is to say, wherein there is no presence save that of the brain by means of the fibres.* Respecting these points, see the treatise on the Fibre.[2] Moreover from what follows it will be clear that there is nothing continuous in the whole body save the fibre of the brain. *But in order to form the animal organism, this fibre makes various circumvolutions. First, however, and before entering on the work of formation, it forms the vessels of the body, which shall be its associates in forming the organs of the body.* Apart from the bloodvessel, the fibre does not form anything that can be called purely corporeal or bodily; since for the existence of a body there must be blood and bloodvessels. But the blood must be prepared from spirits, that is, from the essence of the fibres, together with elements taken in from the circumambient world; and vessels must be formed from fibres and the circumvolutions thereof into the form of a canal. Then, in

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[1] See GENERATION, n. 343.

[2] See the FIBRE, n. 314 *seq.*

order to perfect this work and lead it back to the brain so that there may be a communication [between body and brain], there is required a corporeal fibre which shall constitute the inmost coat of the arteries and the outmost of the veins. Respecting this fibre see the Treatise on the Skin.[1]

5. *From the bloodvessels thus prepared are formed the first membranes; and these everywhere mark out the primitive rudiments and project the warp thereof; but they do this successively one after another.* This is apparent to the sight in the bodies of embryos and infants, where all the membranes,—the skin, and the web-like tissues everywhere,—are highly sanguineous and ruddy. *But in process of time these membranes from being sanguineous become filamentary and as it were ligamentous and tendinous. This occurs when the filaments are no longer traversed by blood but by a serosity secreted from the blood,—in which case the membranes grow pallid.* This is plainly conspicuous in the larger vessels such as the umbilical, and, moreover, in the vessels of the skin, and also in the ductus arteriosus. For those vessels that in the earliest stages had been sanguineous, afterwards grow pallid and become tendinous, or consist of threads of a different kind. The extreme redness of the skin,—nay, of all the membranes,—in embryos and new-born infants, is a circumstance on which we are sufficiently informed by actual sight. An indication of this kind of formation remains also in adults; for even the palest skin will often blush in a moment with the most intense redness,—showing that the blood is then continued into threads which it had previously deserted. *After these membranes, which delineate the first rudiments of the bodily organs, come the muscles, which lie between duplicatures of the membranes. But in order for the formation of muscular fibres, there must first be determined to this membrane vessels of some size, both arterial and venous, and also a fascicle of fibres.* The pre-existence of the membrane that serves as a sheath to the muscle inserted into it, is plain from the formation of the several muscles which are finally inserted into these sheaths and there increase; as is seen in the face, over the cranium,

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[1] 2 A. K. 484–530. See particularly on the corporeal fibre n. 504–507, and also n. 540. The work on the FIBRE includes a chapter (n. 168 *seq.*) specifically devoted to the corporeal fibre.

and elsewhere. For the motive fibres of the muscles are constructed of bloodvessels together with the genuine fibres of the brain, as will be clearly seen from the genesis of muscles.[1] *When the blood deserts their vessels, these muscular fibres produce the tendinous fibres, which are not active like muscular fibres, but passive, corresponding to the activity of the former.* That the tendinous substance which has invariably become adherent to the muscular fibres, was formerly muscular, is sufficiently evident from the laws of formation, see Trans. I.[2] *From the tendinous fibres arise cartilages, and from the cartilages bones,—sooner or later according to the order and needs of nature.* The fact of such a transformation is evident from all the particulars; for the tendinous changes into the cartilaginous and this into the osseous. Consider merely the formation of the embryonic frame, and compare this with the growing and adolescent body, and you will plainly see this process of formation.

6. *But in order to the existence of the viscera or soft parts, there must be formed minute glands, or minute quasi muscular parts formed of fibres of the brain and bloodvessels, together with the more general muscular tegument. These glands give origin to their fibres, which are to be termed corporeal fibres, and which in conjunction with bloodvessels and genuine fibres enter upon the work of weaving and shaping the viscus.* This may be seen from the viscera themselves, which we have already treated of in detail.[3] Respecting the glands that produce the corporeal

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[1] *Ut ex genesi musculorum comparabit.* Dr. Wilkinson takes this to be a reference to a proposed work on "The Genesis of the Muscles," and this is not improbably the case. A treatise on the muscles was intended as a part of Swedenborg's anatomical series; see 1 E. A. K., n. 142, which refers to a "Transaction on Myology," in which the origin of muscles was to be explained. A MS. containing what is presumably a first draft of such a Transaction is reproduced in PHOTO. MSS. Vol. VI § 3; see GENERATION n. 3, note. There is also another MS. (not reproduced) of twenty-two pages, which deals with the muscles; but it consists almost wholly of quotations. See 3 DOCUMENTS p. 860, 866, 942.

[2] *Cf.* 1 E. A. K., n. 251, 252, on the Laws of Formation, and n. 230 on the Muscles.

[3] *i. e.* in the ANIMAL KINGDOM.

fibres, see the treatise on the Skin.[1] From these considerations we now proceed to the periostea.

7. *But it is especially to be observed, that all this formation progresses exactly according to the order of nature, and in fact, successively from the most perfect form through forms less perfect to that which is last or most imperfect. The first form of all is the spiritual form which must be attributed to the soul itself. From this is produced the celestial form which is the form of its purest organic substance wherein the soul transacts the functions of its rational mind. This again produces the vortical form, that is, the form of organic substance, which is properly called the vortical form and the fibres produced wherefrom emulate the same form. This form then produces the spiral form which is that of the whole brain, of the viscera, of the nervous fibre in general, and also of the motive fibre. And lastly, the spiral form produces the terrestrial or angular form such as exists in tendons, ligaments, cartilages and bones.* But on these subjects see the Doctrine of Forms.[2]

8. *With these premises we can now see what is the origin or genesis of the periostea. The last tunic of the muscles is continued all the way to fixed boundaries or solid substances; for the muscle, which is a soft substance, cannot found its forces upon soft extremities, but needs more solid extremities, which shall offer resistance. Hence the outmost of the two layers constituting the periosteum, is a continuation of the vascular tunic that surrounds the muscular flesh.* This membrane is the envelope or sheath of the muscle, and is prior to the muscle. Thus by its continuation here, it marks out the form of the parts which it is about to form. That the marking out is done by this membrane, is evident in the case of the loins, feet, arms, vertebræ, and cranium. For, consisting of mere vessels, it is the first to come into existence, and it afterwards encloses in its duplicature either the muscles or the bones, or both muscles and bones. Moreover, it is this membrane which contains the pericranium and dura mater in the beginning of their formation, but which is afterwards separated from them by the intervention of the cranium. And since this membrane is at first vascular, therefore, in process of time it becomes pale,

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[1] See n. 5, note.

[2] See the FIBRE, n. 255 *seq.*

being deserted by all but the larger vessels. *The nature of the continuity of this membrane is apparent from the nature of the panniculus carnosus*[1] *and the other muscles which direct the whole circumference of the body; it is also seen in the head, in the cranium itself and even within the cranium; for the dura mater is the internal periosteum of the cranium.* From the muscular integuments it goes over the bones where it is attached and spread around. This membrane therefore has a wider extension than any other membrane, and even than the skin itself; for it is, so to speak, the first line that projects the whole warp into a plane.

9. *The second or inner layer of the periosteum (for it is composed of two membranes) consists simply of tendinous filaments drawn out from the muscular flesh. This layer immediately surrounds the bones, and inserts and implants its roots in fixed spots therein, in order that the bones may yield to the muscular force and be flexed according to the set order of nature.* For, excepting in the heart and viscera which are hollow and soft, all the tendons of the muscles attach themselves to cartilages and bones, as to solid termini, with a view to enabling them to put forth their force and to call those parts or appendages into motion. On this account also they demand and claim for themselves the inmost place, or that next the bone. *This layer, however, is not uniform throughout, being in some places thick or dense, in others thin, while in others again, as on the temples, at the sides of the cranium, and elsewhere, there is no trace of it, but the naked bone begins to appear. This layer consists of resolved tendinous threads, and as it were of a loose aponeurosis, intermixed with which are bloodvessels and also fibres which are on their way to penetrate into the interior parts of the bones.* This is clear at first sight; for the compact tendons are of a hardish texture, and by their means this vaginal tunic of the muscles is attenuated, and, under the name of peridesmium, penetrates the vessels between the layers of the periosteum; it is then split into threads, and, by these divisions into threads or parts, it is rendered soft. *The threads of this layer either loosely surround the bones, or are inserted somewhat*

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[1] A thin subcutaneous muscle serving to move the skin. It is found in the forehead, neck, scrotum, etc.

deeply into their very substance,—as is the case when the bones are to be moved by the muscles,—or they also combine into bundles, and determine themselves to other parts of the bones; and since motions are to be continued mechanically through the connection of parts, these bundles are termed ligaments. There are innumerable such ligaments, which go from one bone or from one ginglymoid articulation[1] to another,—as in the ossa innominata, the pelvis, the vertebræ, the false ribs, etc. It is solely the disposition of the parts, that causes the substance to appear more or less soft or hard or tender, and to be determined in one way or in another, and particularly, to conduce to the continued connection of the motions. *The continuity of this layer becomes evident also on anatomical examination of the skeleton; for it is there continued over all the bones both of the body and of the head. Under the form of a white aponeurosis it also distinguishes one muscle from another. Finally, it proceeds to the vertebral column and constitutes the tunica vaginalis of the spine, which goes by the convex and also by the concave part of the spine all the way to the junction and articulation between the cervical vertebræ and the occiput. Here it expands around the cranium and the bones of the head, being termed the pericranium where it covers the cranium.* This continuation of the membrane is shown by mere anatomical inspection. It is clear therefore that its extension is exceedingly great. It takes origin behind the veil of the upper layer of the periostea, since it arises from the motive fibres,—for every tendon and aponeurosis was once muscular, but being deserted by the blood it contracts and becomes a tendon. *This layer serves as a cushion for the bloodvessels and nerves, whereby they may pass in the freest manner into the osseous substance and its medulla or marrow. For were it at all hard, neither the vessels nor the nerves would pass into the bones in accordance with the whole end for which nature formed them; and therefore as soon as ever this layer is thickened and stopped up with humor, then is lost not only the power of the muscles over the bones, but also the faculty of articulation; indeed caries and exostoses are the result whenever this lamina is abraid-*

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[1] A ginglymoid articulation is one that permits motion on a single axis approximately transverse to the long axis of the bone. The knee-joint is an example.

ed, or suffers any other lesion. Mere experience, medical or empirical, shows this; and it is also supported by reasoning based on the connection of the parts; for in the cases referred to, the path for the nourishment of the bones is subverted and obliterated.

10. *These two layers of the periosteum are perfectly distinct from each other. The inmost layer is also perfectly distinct from the surface of the bone; for it does not adhere to it except where tendinous or ligamentous threads and also bloodvessels and nervous fibres are inserted into the bone. And since the two layers are thus distinct and the texture of the periosteum is lax or loose, it follows that there is some kind of liquid permeating and circulating through it; that liquor, namely, which is expressed from the muscles, especially when set in motion, and is collected between the motive fibres and in the cellular tissue of the muscles,—a liquor which is both oily and watery, and which gently touches and anoints the bones.* The motion of these layers arises from that of the surrounding muscles, which, as they are variously called into play, exert a variant action upon the layers, and indeed a reciprocal action between the internal periosteum and the external, causing a drawing to and fro, whereby the liquor is driven from part to part. The extension of these membranes shows the nature of the circulation. *According to the common rule, all this liquor tends from the circumferences to the centers, or from the greatest motion to the least, and hence from the several bones which are the circumferences to the vertebral column which is the central axis of the bones.* The reader will find this rule confirmed everywhere, as also the statement that the vertebral column is the axis and central region of all the bones of the body, that is of the whole skeleton. *And so when it reaches the vertebral column, it rises both outside and inside; and by a kind of pumplike action as of a syringe, it is drawn up all the way to the cranium where resides the supreme or veriest central part of the body.* Respecting the manner of this pumping see the treatise on the Vertebral Column, and also that on the Cranium;[1] for thither does the liquor mount, and there its gyre is terminated. *In this place, that is to say, in the cranium, this oleaginous liquor seems to be sent outwards, that is, to go off in the form of effluvial halitus; it also supplies nourishment to the hair and bones.* In these subjects the reader is requested to wait for the treatise on the Brain. The fact that a large quantity of a fatty and unctuous liquor of this kind is found in the vertebral sheath, and finally around the pericranium, is clear from mere experience. *But with regard to the juice that exudes from the membranous filament, it seems to be expressed at one and the same time in the very vertex or central place, or from the external periosteum and from the internal, which is the dura mater.* And indeed, by virtue of the same causes. This juice is the same as that which is commonly excreted from the external parts after the residual serum has left it,—a juice that is fluid and comparatively fatty.

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[1] No such treatises are found among the author's writings. The work on the Brain, however, contains a chapter on the Cranium (n. 190 *seq.*), which the reader may consult for further particulars.

11. *But the fluid that circulates through the muscular membranes and their cellular tissues and finally through the periostea, is discharged in divers places; that is to say both into the adipose cells whence comes fat (for the adipose tunic lies next to the panniculus carnosus), and into all the interstices; it can likewise be discharged through the more open pores of the skin, in which case it goes off into sweat; and again, towards the peritoneum and pleura, whose channels of discharge have been already pointed out.*[1] *For when the pores of the skin are shut and perspiration prevented, it then circulates through the periosteum or is driven towards the peritoneum and pleura; and* vice versa. It is well worth our while to inquire into this circulation, since the health of the body for the most part depends upon it. For when the pores of the skin are obstructed, and the body is not roused up by any motion, all this excrementitious humor is put back into the circulation, and also into the periostea, whence the latter are infested by this worthless kind of serum,—as may be concluded from the stuffing experienced during catarrh; or else it is sent towards the peritoneum and pleura; but the more fatty portion remains in the adipose tunic. For the viler part is always cast out through the doors of the skin or sent off into banishment elsewhere, while the more genuine part is absorbed by the veins and lymphatics. The residue, which serves as an ungent, circulates through the cellular tissue and also through the periostea. That such is the case is evident from anatomical examination. For from the panniculus carnosus, ducts open out towards the pleura and peritoneum, and also towards the skin and its pores, as was established above.[1] Hence the practical art and science of animal nature consists in this,—that the viler parts be rejected and the better retained. How this is effected will be explained in our Pathology,[2] for there we can confirm our position by experimental testimony. This equilibrium depends on the natural state of the body; and the loss of it on the change of that state. How many are the causes of that state will be seen in our Rational Psychology.[3]

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[1] See 1 A. K. 312 *seq.*, 420 *seq.*, particularly n. 325, 426–428.

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[1] See 2 A. K. n. 492, 493, 504, *seq.*

[2] The work referred to as being in contemplation seems to be the one mentioned in the prospectus printed in volume 1 of the ANIMAL KINGDOM as constituting "Part XI" of the whole series, and which is entitled, "The Affections of the Body, that is to say, Diseases, particularly those of the head or cerebrum." The work on Diseases of the Fibre, which is included in the work on the FIBRE, was probably to have been incorporated in this "Part XI."

[3] The Latin is *Pathologia* (Pathology).

INDEXES, ETC.

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* In the first part of his work Swedenborg simply assumes the common theory as to the course of seed in the female organs; but when he comes specifically to the matter, he gives many reasons for rejecting this theory. An illustration of this policy, may be seen in n. 171, where he speaks as if the animalcules enter the ovum; but immediately afterwards, n. 174, when taking up the matter specifically, he states that they do not.

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SOME CORRECTIONS

To the Text of the Latin Edition of the Works Contained in the Present Volume

In the course of translation, a number of places were noted where there seemed a probability that the MS. had been misread. These were submitted to Mr. Alfred H. Stroh, of Stockholm, for comparison with the original. The following is a result of Mr. Stroh's comparison:

De Periosteo—p. 6, l. 22, *for* inter, *read* intra (very obscurely written).

De Mammis—p. 15, l. 5. *for* universum, *read* urinosum.

l. ult., *for* activis, *read* arteriis.

p. 17, l. 4, inf., *for* alterum, *read* oleum.

De Generatione—p. 1, l. 13, *for* in aorta, *read* de aorta.

p. 7, l. 8, *for* puriorem, *read* pauciorem.

p. 31, l. 16, *for* crebro, *read* cerebro.

p. 51, l. 19, *for* rigoris, *read* vigoris.

p. 41, l.31, *for* activis, *read* arteriis.

p. 45, l. 23, *for* intinere, *read* itinere.

p. 51, l. 31, *for* racementa, *read* recrementa.

p. 56, l. 6, *for* viam, *read* vim.

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p. 67, l. 23, *for* tunicis, *read* truncis.

p. 71, l. 2, inf., *for* minores, *read* majores.

p. 73, l. 20, *for* secundarias, *read* secundarios.

p. 74, l. ult., *for* quando, *read* quondam.

p. 76, l. 5, *for* motum, *read* modum.

p. 86, l. 24, *for* directionem, *read* delineationem.

p. 88, l. 5, *for* tum, *read* tunc.

p. 89, l. 8, *for* amoribus, *read* omnibus.

p. 89, l. 10, *for* Hae causae, *read* Haec causa.

p. 89, l. 27, *for* successione, *read* succussione.

p. 105, l. 5, *for* continuae, *read* continuo.

p. 105, l. 20, *for* primitive, *read* primitivi.

p. 110, l. 3, *for* aperta, *read* operta.

p. 110, l. 30, *for* fistulam. *read* fossulam.

p. 137, l. 30–31, *for* fibrillarum, *read* fibriarum [*i. e.* fimbriarum].

p. 139, l. 13–14, *for* origine compassionis, *read* vaginae [?] compressionis.

p. 155, l. 25, *for* parit, *read* paret.

p. 157, l. 18, *for* oppositam, *read* appositam.

p. 163, l. 15, *for* sed, *read* sic.

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p. 170, l. 15, *for* docemus, *read* docemur.

p. 198, l. 6, inf., *for* deposcat, *read* depascit

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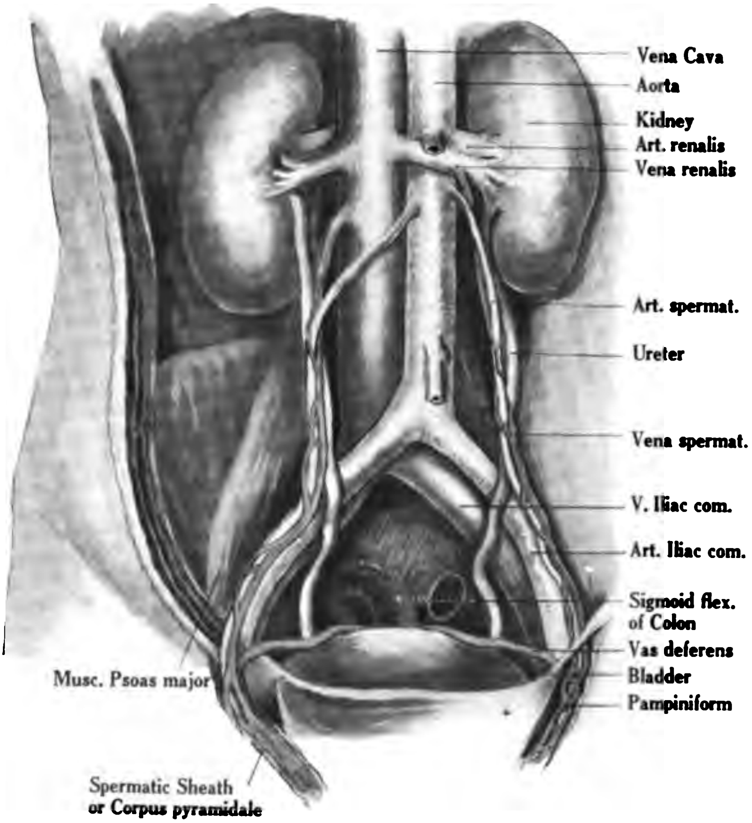


Diagramatic view of a part of Abdomen and Pelvic cavity

Plate II

Figure 1

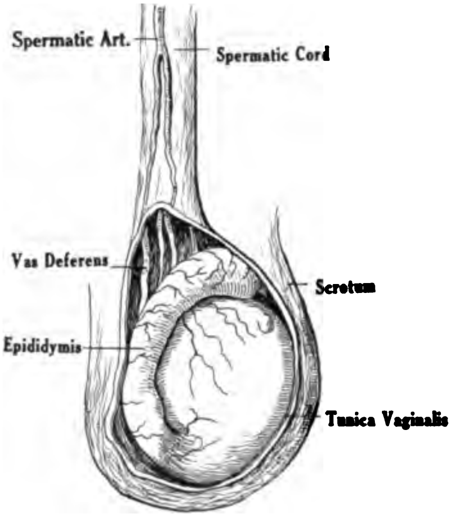


Figure 2

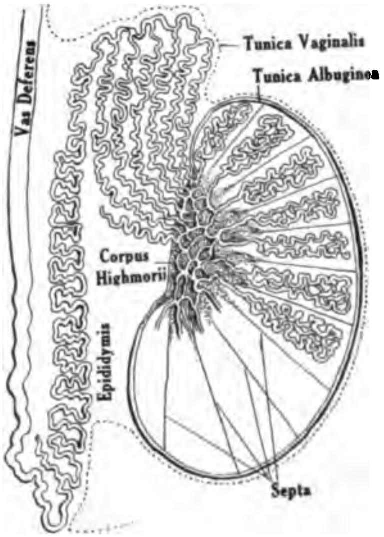


Fig. 1. The Testicle with its tunics and vessels.

Fig. 2. Vertical section of the Testicle showing the arrangement of ducts and indicating the tunics.

Plate III

Figure 1

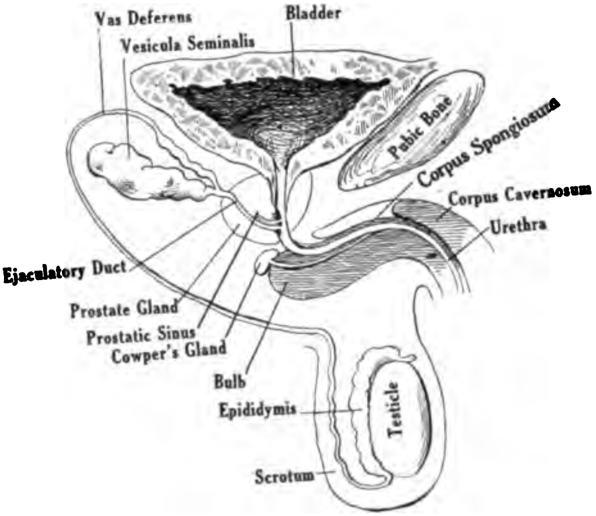


Figure 2

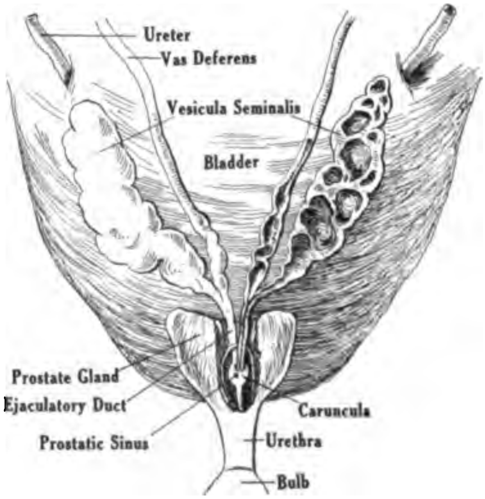


Fig. 1. Diagramatic representation of the male generative organs. The Caruncula is indicated in this figure by a narrowing of the Urethra at the point of entrance into it of the Ejaculatory duct.

Fig. 2. The base of the Bladder and upper portion of the Urethra. A portion of the Prostate gland has been cut away to show the full length of the Ejaculatory duct.

Plate IV

Figure 1

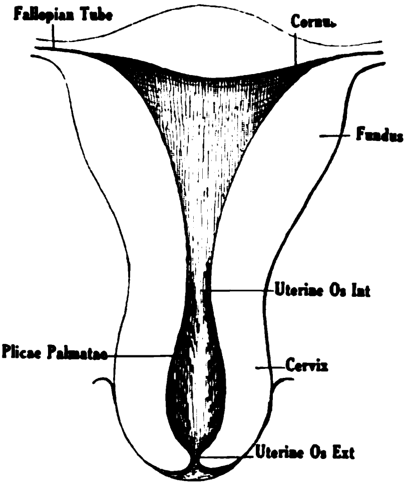


Figure 2

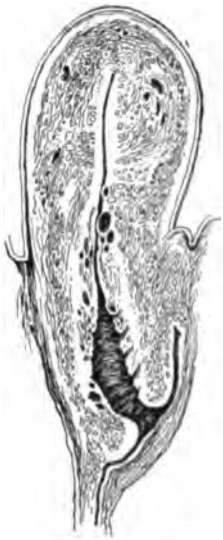


Fig. 1. Diagramatic representation of the Uterus (nullipara) with Plicae palmatae shown in Cervix.

Fig. 2. Longitudinal section of Uterus and upper part of Vagina, at right angles to the above.

Plate V

Figure 1

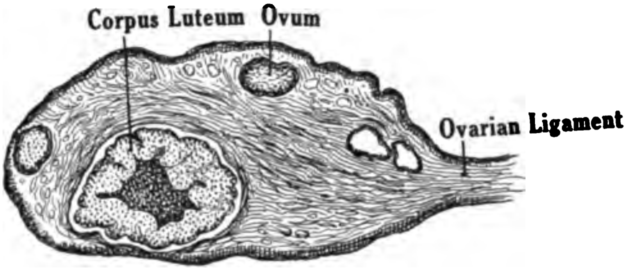


Figure 2

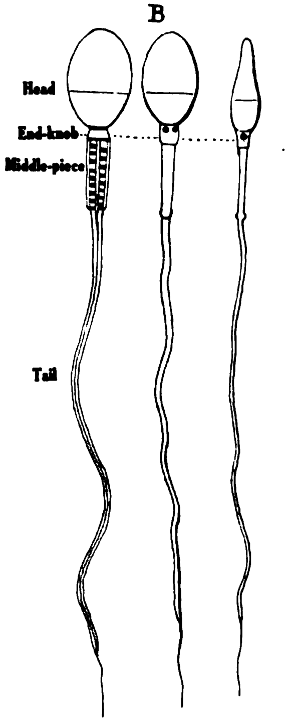


Figure 3

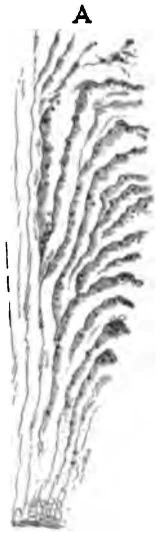


Fig. 1. Longitudinal section through Ovary.

Fig. 2. Spermatozoa, giving surface and lateral views. **X 1200.**

Fig. 3. Plicae palmatae (magnified) of the uterine Cervix. The dots show the openings of the cervical glands into the canal of the Uterus.

Plate VI

Figure 1

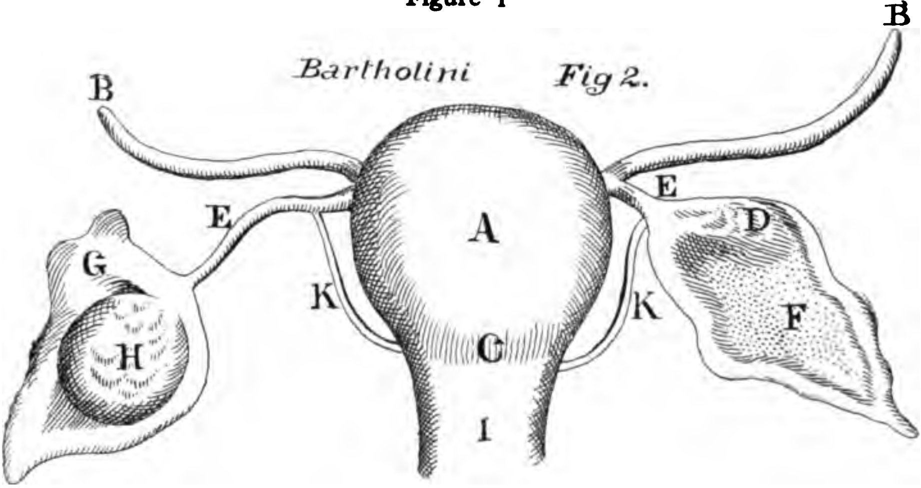


Figure 2

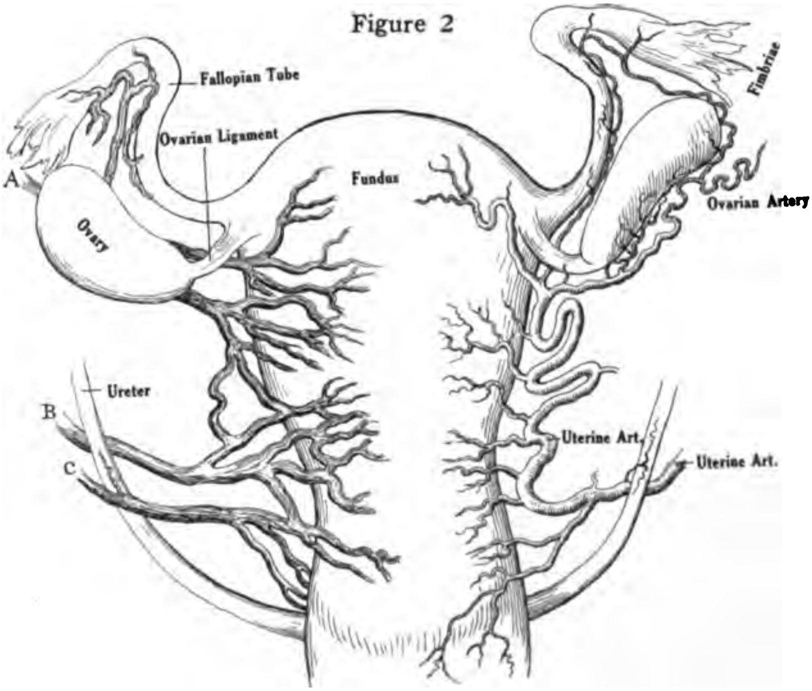


Fig. 1. A copy of Bartholini's figure 2, referred to in the text.

Fig. 2. Uterus with arteries shown to the right and veins to the left. **A** sends blood collected to Vena spermatica, see Plate **I.** **B** and **C** empty their contents into the Vena hypogastrica or Internal Iliac.

Plate VII

Figure 1

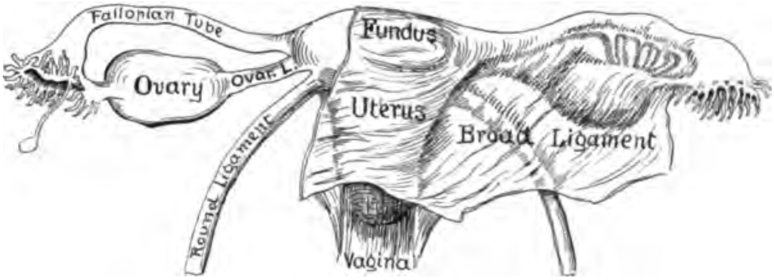


Figure 2

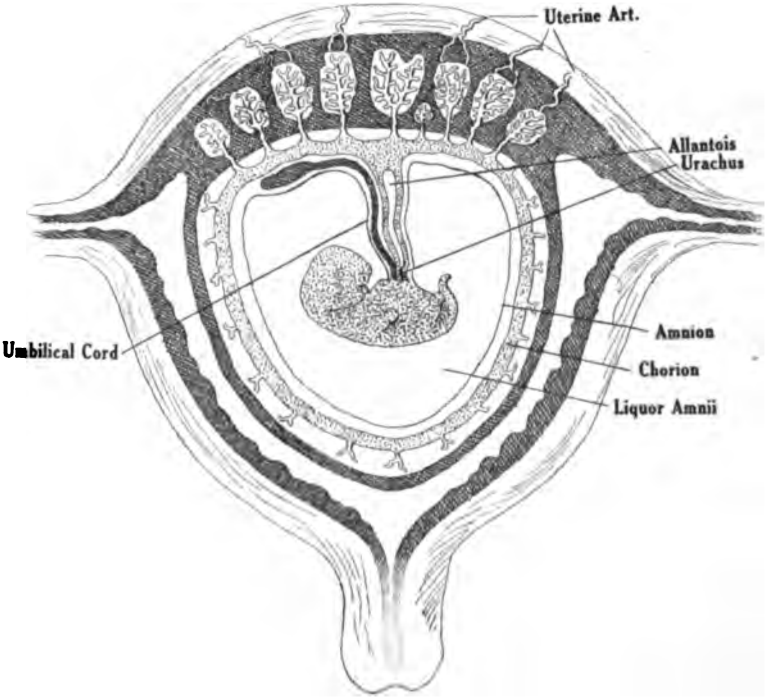
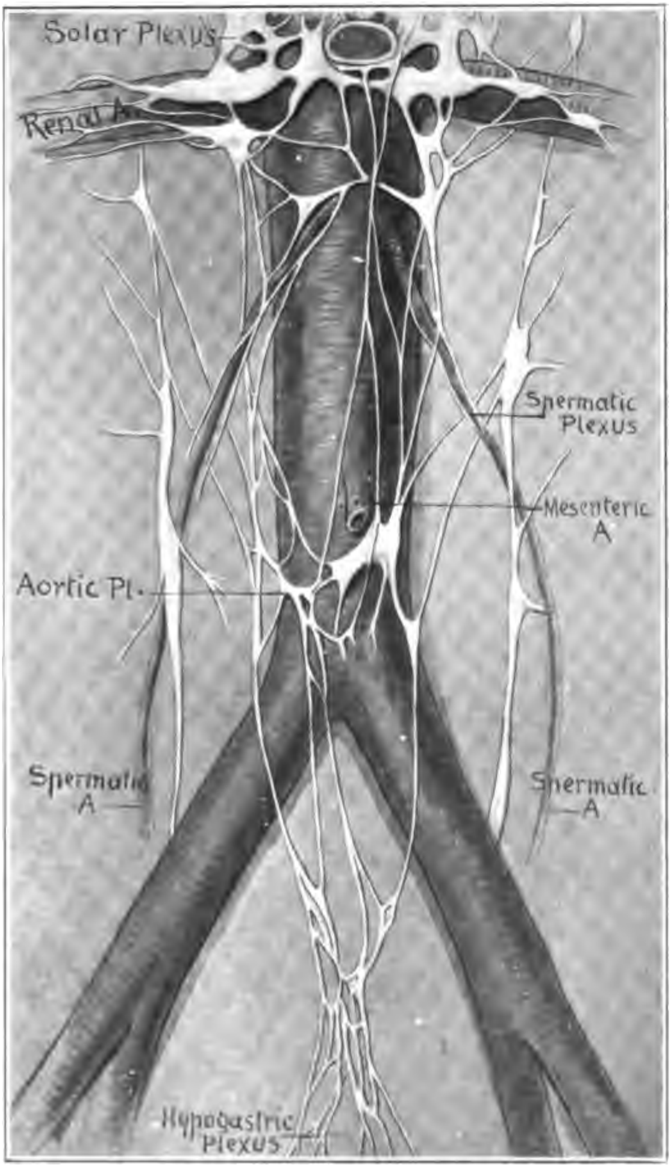


Fig. 1. The internal female generative organs. View from before.

Fig. 2. Diagram of the relations, during pregnancy of the Fetus and different parts of the Uterus.



Lumbar portion of the Sympathetic system. The Mesenteric plexus is not shown although it is a part of this system; it is further in front. The superior and the inferior Mesenteric plexuses being respectively below the Solar and above the Hypogastric plexuses, deriving their fibres principally from these.

Plate IX

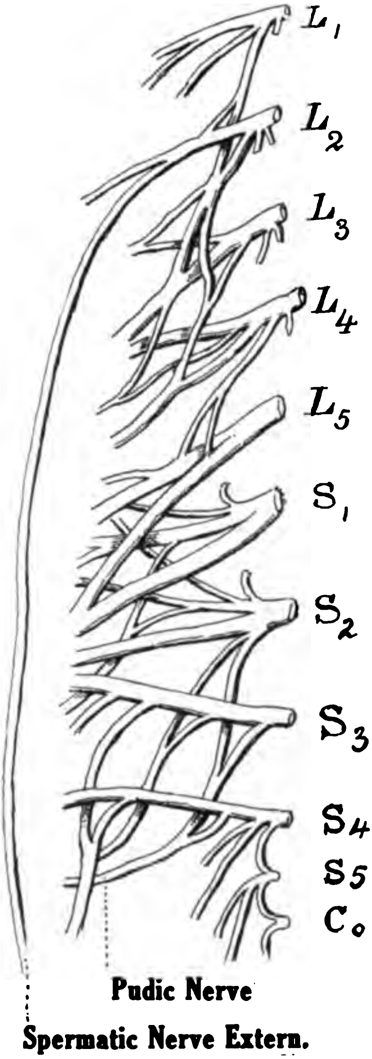
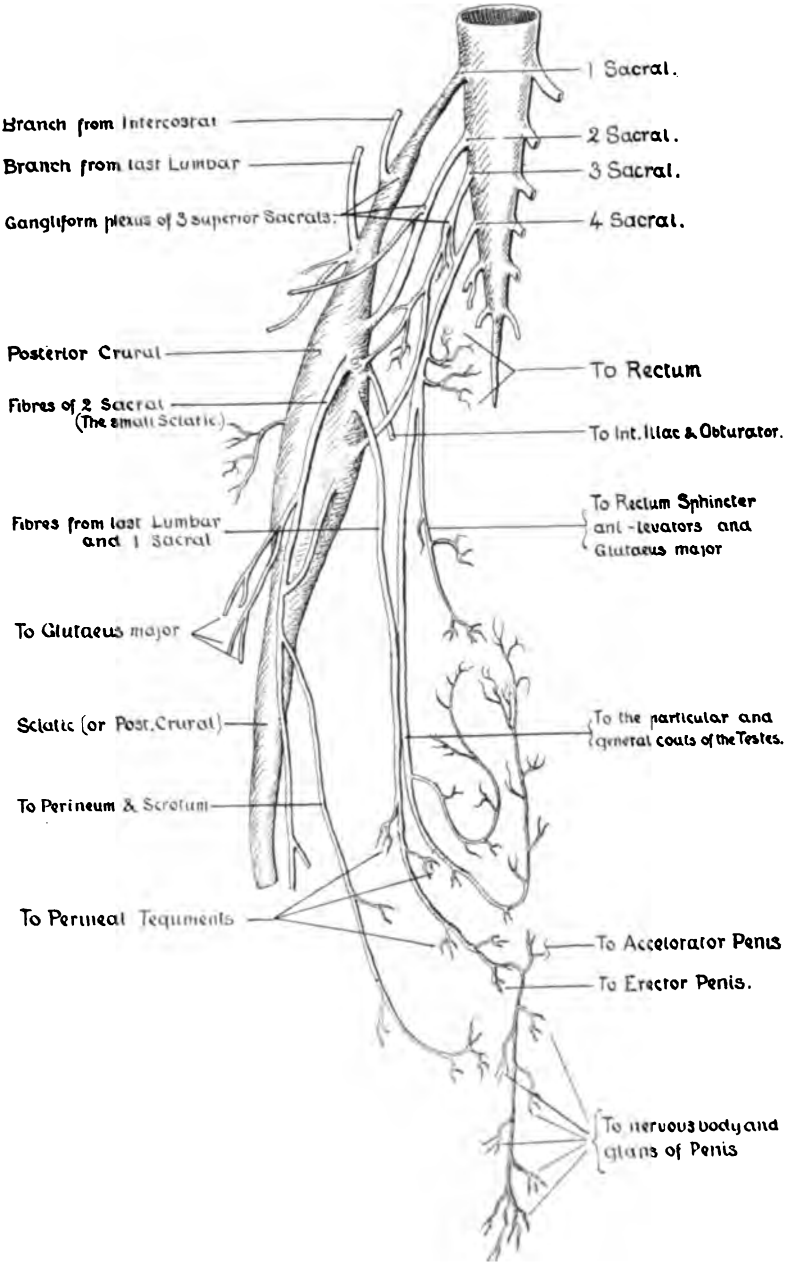


Diagram of the Lumbar and Sacral Plexuses. Showing the origin of the Pudic and Spermatic nerves. **L** refers to lumbar and **S** to sacral spinal nerves.

Plate X


1 Sacral.
Branch from Intercostal
2 Sacral.
Branch from last Lumbar
3 Sacral.
Gangliform plexus of 3 superior Sacrals:
4 Sacral.
Posterior Crural
To Rectum
Fibres of 2 Sacral
(The small Sciatic)
To Int. Iliac & Obturator.
To Rectum Sphincter ani-levators and Glutaeus major
Fibres from last Lumbar and 1 Sacral
To Glutaeus major
To the particular and general coats of the Testes.
Sciatic (or Post. Crural)
To Perineum & Scrotum
To Perineal Teguments
To Accelorator Penis
To Erector Penis.
To nervous body and glans of Penis

Copy of Vieussens', **Fig. XXIX.** The text of this figure is taken from Vieussens' description.

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